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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Chemical and Spectral Procedures

Refer also to abstracts 19066 and 19254.

18873 (NLCO–1047) ATOMIC ABSORPTION METHODS FOR THE DETERMINATION OF MICROGRAM QUANTITIES OF RUTHENIUM IN URANIUM MATERIALS AND OF ZIRCONIUM IN URANIUM AND THORIUM MATRICES. Jursik, M. L. (National Lead Co. of Ohio, Cincinnati). 20 Aug 1969. 24p. (CONF-690942–1). Dep. CFSTI.

From 13th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A ruthenium-bearing uranium sample is dissolved by heating with concentrated perchloric acid in a distillation apparatus. The ruthenium is oxidized to the volatile Ru^{8+} by fuming and is simultaneously distilled into an ice-cooled receiver. The distillate is aspirated into an air–acetylene flame, and the absorption is read at 3499 Å. The ruthenium calibration curve is a straight line in the range of 0 to 5 μg ruthenium per ml. Interferences were explored; however, no anion or cation effects were detected. A comparison of the absorption results with those obtained colorimetrically showed good agreement. A single determination can be completed in 1 hour by atomic absorption; a determination by the colorimetric method requires 8 hours. Sensitivity is 0.3 μg ruthenium per ml per 1% absorption. A zirconium-bearing uranium or thorium sample is dissolved in 7 M hydrochloric acid and extracted with TTA–xylene. The organic phase is aspirated into the nitrous oxide–acetylene flame. At a wavelength of 3601 Å, the organic medium enhances the response for zirconium by a factor of 9. The zirconium calibration curve is a straight line in the range of 0 to 50 μg zirconium per ml. Eight ppM zirconium, metal sample basis, can be easily measured in a 5-g sample. The principal interferences are from fluoride, phosphate, and sulfate ions, but at levels above those usually found in metallic samples. Sensitivity is 1 μg zirconium per ml per 1% absorption. (auth)

18874 (RFP–1344) INSTALLATION OF A FLAME SPECTROMETER FOR THE ANALYSIS OF RADIOACTIVE SOLUTIONS. Johnson, Andrew J.; Shepherd, Glen A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 9 Mar 1970. Contract AT-(29-1)-1106. 3p. Dep. CFSTI.

A Jarrell-Ash Model 82-360 Atomic Absorption Flame Spectrometer was installed in a specially designed glove box for use in the analysis of radioactive materials. The design and installation of the glove box, the ventilation and safety precautions, and the analytical operation of the instrument are discussed. Examples are given of the types of analyses performed. (auth)

18875 (RFP–1449) A FORTRAN IV PROGRAM FOR REDUCTION OF SPECTROPHOTOMETRIC REACTION KINETICS DATA. Werkema, George J. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 11 Mar 1970. Contract AT(29-1)-1106. 10p. Dep. CFSTI.

A program written in E-level FORTRAN IV for the IBM 360-40G computer for reduction of spectrophotometric reaction kinetics data is presented. The program reduces spectrophotometric absorbancy data to molar concentrations of reactants and products and, at the user's option, computes the rate constant time products (k_1 t, k_2 t, and k_3 t) using the integrated forms of first-, second-, and third-order rate laws. (auth)

18876 (UCRL–72009) REAL-TIME COMPUTER PREDICTION OF END POINTS IN CONTROLLED-POTENTIAL COULOMETRY. Stephens, F. B.; Jakob, Fredi; Rigdon, L. P.; Harrar, J. E. (California Univ., Livermore. Lawrence Radiation Lab.). 5 Feb 1970. 52p. (CONF-700303–1). Dep. CFSTI.

From Conference on Analytical Chemistry and Applied Spectroscopy, Cleveland, Ohio.

Two real-time computer techniques have been developed for predicting the final value of the charge in a controlled-potential coulometric determination. One method, for which a suitable instrument has been designed, is an analog-type computation. The other technique employs an on-line digital computer programmed to perform the calculation. A procedure has been developed for handling background current corrections for predictive coulometry so that the technique can be used as an absolute method. Both analog and digital systems yield analytical results with an accuracy and precision of 0.1 to 0.2%, in one-third the electrolysis time required for conventional controlled-potential coulometry. The systems also incorporate a readout of the electrolytic rate constant. This feature is useful for testing an electrochemical system for conformance to the simple exponential rate law, which is necessary for accurate prediction, and for detecting kinetic complications in the electrochemical reaction. Examples are given using Pb, V, and U. (auth)

18877 (UNC–5245) DEVELOPMENT OF ANALYTICAL METHODS FOR THE DETERMINATION OF NITROGEN IN SODIUM. Final Report. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). Feb 1970. Contract AT-(30-1)-4070. 39p. (NYO–4070-1). Dep. CFSTI.

Development of an analytical method for the determination of chemically combined nitrogen in sodium is described. The method is based upon fusion of sodium with lithium at 650°C, followed by solution of the mixture, steam distillation, and spectrophotometric measurement of the distillate. Successful application to nitrogen combined as nitrate, cyanide, and cyanate is demonstrated. Incomplete recoveries of nitrogen added as nitrite are found. An alternative technique based on fusion with sodium hydroxide in a hydrogen atmosphere is shown to yield incomplete recoveries of chemically combined nitrogen in sodium. (auth)

18878 INVESTIGATION OF n-BUTYL PHOSPHATE AS A SOLVENT FOR VOLTAMMETRY. Jones, Jerry L.; Adisesh, Setty; Smith, Robert M.; Karnes, John H. (Texas A and M Univ., College Station). Anal. Chim. Acta; 49: 487–96 (Mar 1970).

Controlled potential voltammetric investigations of several depolarizers and potentially useful carrier electrolytes have been carried out in n-butyl phosphate. Half-wave potentials have been measured and analytical calibration curves have been constructed. Most depolarizers gave well formed waves but adsorption behavior was present in some cases. The influence of water was very significant. (auth)

18879 TITRATION CURVES OF COMPLEXIMETRIC BACK-TITRATIONS. PART III. CONDITIONS FOR SHARP END-POINTS WITH INDICATION BY MEANS OF AN INDICATOR ION. Hannema, U.; Prakash, S.; Den Boef, G. (Univ. of Amsterdam). Anal. Chim. Acta; 49: 557–61 (Mar 1970).

Conditions were derived for sharp end points in compleximetric back-titrations of mixtures of metals, by means of potentiometric indication of one of the metals of the mixture. Some applications are given for the determination of Cu, Zn, Bi, and Ni with EDTA as the ligand and thorium(IV) as the titrant. (auth)

18880 VACUUM-FUSION DETERMINATION OF OXYGEN IN Al–Mg–Al_2O_3–MgO COMPOSITES. Colombo, A.; Rodari, E. (EURATOM-CCR, Ispra, Italy). Anal. Chim. Acta; 49: 584-7 (Mar 1970).

In the vacuum-fusion method for the determination of O in Al–Mg–Al_2O_3–MgO, a flux technique was used that, in order to reduce the evaporation of volatile metals, provides for sealing the sample with the flux (in this case, Cu) in a small graphite capsule firmly closed with a screwed cover, which is dropped into the hot crucible of the instrument for the analysis. The Al–Mg–Al_2O_3–MgO composites are currently being studied for potential usage as canning and structural materials in nuclear reactors. (P.C.H.)

18881 THE SPECTROPHOTOMETRIC DETERMINATION OF SCANDIUM WITH ERIOCHROME BRILLIANT VIOLET B. Uesugi, Katsuya (Himeji Inst. of Tech., Japan). Anal. Chim. Acta; 49: 597-602 (Mar 1970).

A new spectrophotometric method for the determination of Sc using Eriochrome Brilliant Violet B, which is similar in structure to Pontachrome Azure Blue B, is described. The effects of various ions on the determination were examined under the conditions of the standard procedure. The ions were added, individually, to solutions containing 0.4 ppM of Sc (in the final solution). The results indicated that Al, Be, Cd, Cr(III), Cu(II), Th, Fe(III), Pb, Y, and the rare earth elements interfere seriously. Several methods were tested to eliminate the interfering ions, and an anion exchange method proved most satisfactory. (P.C.H.)

18882 DETERMINATION OF ^{18}O ISOTOPIC CONSTITUTION OF OXYANIONS USING RAMAN SCATTERING. Melveger, A. J. (Univ. of Maryland, College Park); Johnson, E. R.; Loadov, E. N. J. Inorg. Nucl. Chem.; 32: 337-9(Jan 1970).

In the course of studying the radioinduced decomposition of $K^{18}NO_3$ the use of Raman spectroscopy to determine changes in isotopic constitution was investigated and found to be very successful. The method also appears very suitable for rapid quantitative estimation of the heavy isotopes of oxygen in Raman active compounds. A Raman spectrometer equipped with a He-Ne laser was used to excite and record the spectra. The spectra of the isotopically enriched salt after irradiation in air are given, an increase in the $^{18}NO_3^-$ and ($N^{18}O^{16}O_2^-$) peak heights was apparent, compared with normal KNO_3, due to the radiation induced back reaction $KNO_2^- + \frac{1}{2}O_2 \rightarrow KNO_3$. The isotopic enrichment was calculated from the Raman spectra by measuring the peak heights, summing, and taking percentages. A comparison was made with the results of spectroscopy. (UK)

18883 OPTIMUM CONDITIONS FOR THE DETERMINATION OF STRONTIUM IN THE PRESENCE OF BARIUM WITH NITCHROMAZO [3, 6-BIS-(4-NITRO-2-SULPHOPHENYLAZO)CHROMOTROPIC ACID] AS REAGENT IN ACETONE–WATER MEDIUM. Kreshkov, A. P.; Kuznetsov, V. V. Tr. Mosk. Khim.-Tekhnol. Inst.; No. 58, 249-52(1968). (In Russian).

The reactions of Sr with nitchromazo(I) in the presence of Ba in the system H_2O–acetone–Na_2SO_4 were studied. The selectivity of the reaction is optimum under the following conditions: concentration of I, 35 μM; maximum allowable Ba concentration, 0.35 mM; a 1.5-fold excess of Na_2SO_4 with respect to Ba; pH = 3.7; and acetone content, 40%. The change in the light absorption of I in the presence of acetone is evaluated; in 40% acetone the change is relatively small. The coprecipitation of Sr with $BaSO_4$ using 0.35 mM $BaCl_2$ was also studied. The extent of coprecipitation was increased when the $BaSO_4$ was precipitated from aqueous acetone solutions. (Referativnyi Zh.)

18884 IODIMETRIC DETERMINATION OF IRON(III) AND CERIUM(IV) WHEN BOTH ARE PRESENT. Mamedov, I. A.; Nabiev, M. N. Uch. Zap. Azerb. Gos. Univ., Ser. Khim. Nauk; No. 1, 14-17(1968). (In Russian).

Iron and cerium are determined in their alloys by iodimetric titration. A 0.5- to 1-g sample is dissolved in 30 to 40 ml of hot 1N H_2SO_4. Any insoluble residue is removed, and to the filtrate are added 40 ml of H_2SO_4 (1:1), 3 ml of 0.25% $AgNO_3$ solution, and 2.5 to 3 g of $(NH_4)_2S_2O_8$. This mixture is boiled for 10 to 15 min and then diluted to 100 ml. To 20 ml of this solution are added 20 to 25 ml of benzene and 3 ml of 3N KI. This mixture is shaken, 20 to 25 ml of water is added, and the solution is titrated to a permanent pink color in the benzene layer with standard $Na_2S_2O_3$ solution. This determines Fe plus Ce. A few pieces of filter paper are added to another 20 ml portion of the sample solution, and the solution is boiled for 1 to 2 min to reduce Ce(IV) to Ce(III). This solution is cooled, and the iron is determined as described. The Ce is found by difference. (Referativnyi Zh.)

18885 DETERMINATION OF MOLYBDENUM IN SOIL WITH o-NITROPHENYLFLUORONE. Dranitskaya, R. M.; Frum, E. I. Pochvovedenie; No. 10, 127-30(1968). (In Russian).

The solution obtained from decomposing a 1g sample of soil is extracted with diethyldithiocarbamic acid in $CHCl_3$, which is then cooled to 5°C, washed with 3N-H_2SO_4, and evaporated to dryness. The residue is taken up in 0.5ml of 1% Na_2CO_3 and 0.3ml of saturated $KClO_4$ solutions, evaporated, and ignited. This residue is dissolved in H_2O; HCl, EDTA, and $KMnO_4$ solutions are added; and after 2 min hydroxylammonium chloride, gelatin, ethanol, and the reagent solutions are added. The solution is diluted to 50ml and after 15 min the extinction is measured at 584 mμ. A calibration graph is constructed for up to 5 μg of Mo. (Referativnyi Zh.)

18886 X-RAY FLUORESCENCE ANALYSIS OF POWDERS USED FOR MANUFACTURING CEMENTED CARBIDES. Vavrda, J. Pokroky Praskove Met. VUPM; No. 1, 39-55(1969). (In Czech).

X-ray fluorescence analysis allows quantitative determination of Co, TiC, NbC, TaC, and Mo_2C in cemented carbide mixtures. The specimens are prepared by compressing the powders, and the components were determined in concentration ranges used in production of cemented carbides. The method was not applicable for the analysis of cemented carbides in presence of Cr_3C_2, which affected the accuracy of TiC determination. The effects affecting the absorption of individual components are discussed and correction formulae are presented. (Metals Abstr.)

18887 DETERMINATION OF LUTETIUM AND THULIUM BY ATOMIC-ABSORPTION SPECTROSCOPY. Fernandez, F.; Manning, D. C. (Perkin-Elmer Corp., Norwalk, Conn.). At. Absorption Newslett.; 7: No. 3, 57-60(1968).

Energy levels and sensitivities are reported for several wavelengths in the spectra of Lu and Tm obtained with an acetylene–N_2O flame. Detection limits are 3 μg of Lu per ml (at 331.2 nm) and 0.2 μg of Tm per ml (at 371.8 nm). The ionization-suppression effects of added K are discussed. (Anal. Abstr.)

18888 NON-RADIOACTIVE PHYSICAL METHODS OF ANALYSIS DURING GASEOUS RE-PROCESSING OF NUCLEAR FUEL. Goossens, W. (CEN, Mol, Belgium). Ind. Chim. Belge; 33: 649-54(1968).

Decladding of the fuel is achieved with HF and O at 550°C; the U is volatilized as UF_6 at <300° after reaction with ClF_3, the UF_6 being adsorbed on NaF, and Pu is volatilized at 450°C to 550° as PuF_6 after reaction with F. Various methods for monitoring the gases involved in the reactions are reviewed; ir spectrophotometry and GLC are of particular value for continuous and discontinuous monitoring, respectively. (Anal. Abstr.)

18889 CHEMICAL ANALYSIS OF PEROVSKITE. Turi, B. (Univ., Rome). Period. Mineral.; 37: 567-75(1968). (In Italian).

A method is described for the chemical analysis of a complex calcium–titanium oxide containing rare earth metals and Nb. Titanium is determined gravimetrically as TiO_2, after separation by hydrolysis and by precipitation with cupferron. Calcium is also determined gravimetrically. The rare earth metals are separated as a group, weighed together as their oxides, and are determined individually by emission spectrography. Iron and P are determined spectrophotometrically, and Nb, Sr, and Zr are determined by x-ray fluorescence techniques. (Anal. Abstr.)

18890 METHOD OF MEASURING CONTAMINATION OF LIQUID SODIUM. Newman, L. (to U. S. Atomic Energy Commission). U. S. Patent 3,493,743. 3 Feb 1970.

A chemical method of measuring the oxygen content of sodium is described. A known amount of $Ag_2{}^{18}O$ is added to a given amount of sodium. Carbon is added to produce CO, which is then analyzed for the ratio of ^{18}O to ^{16}O. (AEC)

18891 ATOMIC ABSORPTION SPECTROPHOTOMETRIC DETERMINATION OF STRONTIUM IN KOLA PHOSPHATE ROCK. Hofer, Andreas (Oesterreichische Stickstoffwerke, Linz, Austria). Z. Anal. Chem.; 249: 115-17(30 Jan 1970). (In German).

The phosphate sample is dissolved in hydrochloric acid. After adjusting the pH of the sample solution to 2 to 3 the cations are separated from phosphate by the cation exchanger Lewatit S 100. Before the cations are eluted with 4 N hydrochloric acid the column is washed with 0.01 N hydrochloric acid. The eluate is diluted and strontium is determined in this solution by atomic absorption spectrophotometry using the method of standard addition. (auth)

18892 DETERMINATION OF DIFFERENT FORMS OF SILICIC ACID IN SOLUTIONS OF URANYL NITRATE WITHOUT PREVIOUS SEPARATION. Nemodruk, A. A.; Palei, P. N.; Bezrogova, E. V. Radiokhimiya; 11: 716-18(1969). (In Russian).

Photometric methods for determination of various forms of silicic acid in solutions of uranyl nitrate without previous separation are described. The determination is based on formation

of yellow molybdosilicic acid, its reduction with Mohr's salt in the presence of Complexon III, and measurement of its optical density. All forms are converted to the alpha form for the determination by heating with NaOH. (tr-auth)

18893 PHOTOCOLORIMETRIC METHOD FOR DETERMINATION OF FLUORIDE IONS IN SOLUTIONS OF TETRAVALENT URANIUM. Vdovenko, V. M.; Romanov, G. A.; Solntseva, L. V. Radiokhimiya; 11: 718-21(1969). (In Russian).

A differential photocolorimetric method was developed for determination of fluoride ions based on the change in color of solutions of U(IV) on the formation of fluoride complexes. (tr-auth)

18894 DIRECT NUMERICAL REDUCTION OF MASS SPECTRA IN ISOTOPIC ANALYSIS. Sigelle, R.; Bernard, G.; Gilles, J.; Kaeuffer, J. L. Method. Phys. Anal.; 4: 400-3(Dec 1968). (In French).

A device for an automatic ratio measurement in isotopic solid analysis by mass spectrometry is described. The needs of these experiments, and the importance of the best signal-to-noise ratio are summarized, and an explanation of how an excellent stability of the magnetic field was obtained, using a Hall-cell and comparison to a reference voltage is given. A peak switching device and statistic measurement of the intensity of a peak by the means of an integrating system allow a precise determination of the isotopic ratios and also increase the number of informations to be obtained during a given time. (auth)

18895 HIGH CARBON CONTENT DETERMINATION BY VACUUM SPECTROMETRY IN COBALT-BASE ALLOYS CONTAINING REFRACTORY CARBIDES. DETERMINATION OF METALLIC ELEMENTS. Malamand, F. Method. Phys. Anal.; 4: 419-28 (Dec 1968). (In French).

A vacuum spectrometer was used to measure the carbon content of various binary and complex cobalt base alloys containing refractory carbides such as tantalum carbide, with a carbon concentration in the range 0.1 to 4.5%, by means of C IV 1548.19 A and C III 977.02 Å lines. By moving the photomultipliers normally used for oxygen and nitrogen titration, we have been able to titrate metallic elements such as Cr, Ni, Ta by means of IV and V lines and for high contents (2 to 40%). The results are reproducibles and they agree with those obtained by other methods: chemical analysis, solution or counter-electrode transfer spectral analysis. In the vacuum spectrometry analysis method, no influence of other elements for studied alloys was noticed. (auth)

18896 COMPLEXOMETRIC DETERMINATION OF MOLYBDENUM(VI). Pribil, Rudolf; Vesely, Vladimir (J. Heyrovsky Polarographic Inst., Prague). Talanta; 17: 170-3(Feb 1970).

In acidic medium molybdenum(VI) forms a stable complex on boiling with excess of DCTA and hydroxylamine hydrochloride. Molybdenum can then be determined by back-titration of the excess of DCTA either with zinc chloride at pH 5 to 5.5 or with thorium nitrate at pH 3 to 4.5, Xylenol Orange being used as indicator in both cases. A simple method for the determination of molybdenum in the presence of moderate amounts of tungsten is also described. (auth) (UK)

18897 STATISTICAL DISTRIBUTION OF SENSITIVITY FACTORS IN SPARK MASS SPECTROMETRY. Vidal, G.; Galmard, P.; Lanusse, P. (National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux, France). Method. Phys. Anal.; 4: 404-11(Dec 1968). (In French).

The absolute analysis by spark mass spectrometry has the flaw of providing a mass concentration which is more or less distinct from the true concentration. The ratio of these two concentrations is called sensitivity factor. 302 values of this factor picked in the literature permit drawing a statistical distribution curve. This curve shows that 90% of the values lie between 0.38 and 6.3. When dividing the sensitivity factors by those calculated from miscellaneous formulas, scattering does not decrease. In the particular case of an iron matrix, that scattering is lowered if the new relation of Honig is used; this scattering is lowered too if one distinguishes two sets of values of the sensitivity factor, corresponding to an impurity boiling temperature higher or lower than the matrix one. These distribution curves permit to define, for a given probability, the lower and upper boundaries of the true concentration starting from the mass concentration. (auth)

18898 DETERMINATION OF MOLYBDENUM, TUNGSTEN, TANTALUM, AND NIOBIUM IN MULTICOMPONENT ALLOYS USING X-RAY FLUORESCENCE ANALYSIS. Schneider, H. Z. Erzbergbau Metallhuettenw.; 22: 338-40(Jul 1969). (In German).

X-ray fluorescence analysis was carried out on W–Mo, ferro–Mo, ferro–W, and Fe–Nb, –Ta alloys using solutions with definite acid concentrations. Reproducibility of the results compares well with wet analytical methods. (Metals Abstr.)

18899 ANION EXCHANGE SEPARATION FOR THE DETERMINATION OF URANIUM IN COMPLEX SOLUTIONS. Vita, O. A.; Walker, C. R.; Trivisonno, C. F.; Sparks, R. W. (Goodyear Atomic Corp., Piketon, Ohio). Anal. Chem.; 42: 465-9(Apr 1970).

Two anion-exchange separations applicable to the determination of uranium in complex nuclear fuel element solutions are described. In a very selective dual ion-exchange process, uranium is adsorbed on Dowex 1-X8 as the anionic nitrate complex from 1.9M aluminum nitrate–0.1M nitric acid and then as an anionic chloride complex from 8M hydrochloric acid without removal from the column. In a less selective single ion-exchange process that is suitable for many applications, uranium is adsorbed on Dowex 1-X8 from 8M hydrochloric acid. After either adsorption, uranium is eluted and determined by appropriate methods. Uranium was separated from solutions containing aluminum, beryllium, molybdenum, stainless steel, and zirconium and determined by titration with potassium dichromate. The effects of nitric acid and fluoride ion on adsorption are described. The relative standard deviation is ±0.4% per analysis with no significant bias. (auth)

Isotopic Procedures

18900 (KFK–1115) NEPTUNIUM ANALYSIS IN NUCLEAR FUEL ELEMENTS. Braun, H.; Brandalise, B.; Koch, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Nov 1969. 14p. (In German). (EUR–4319). Dep. CFSTI (U. S. Sales Only).

A method is described for separation of Np from U, Pu, and fission products. In the presence of a strong reducing agent in 8M HNO_3 only Np is adsorbed on an anion exchange column. The Np was further purified by solvent extraction using TTA. Isotopic dilution analysis with ^{239}Np as indicator was used to calculate yields. No absolute measurement of ^{237}Np activity in the sample is necessary. (M.C.G.)

Radiometric Procedures

Refer also to abstracts 18932, 18985, 19091, and 19234.

18901 (LA–4320) NUCLEAR SAFEGUARDS RESEARCH AND DEVELOPMENT. Program Status Reports, January 1967–June 1969. (Los Alamos Scientific Lab., N. Mex.). 19 Dec 1969. Contract W-7405-eng-36. 186p. Dep. CFSTI.

Contains the following LA reports: LA–3682, LA–3732, LA–3802, LA–3859, LA–3921, LA–3974, LA–4029, LA–4070, LA–4162, LA–4227.

Progress is reported under the following headings: pulsed neutron research, pulsed Cockcroft–Walton Accelerator and auxiliary equipment, absolute delayed neutron yield measurements, dense plasma focus source, mathematical simulation studies of kinetic response measurements, detector development, delayed neutron kinetic response techniques for nondestructive assay of fissionable materials, abundances and periods of delayed neutrons from 14-MeV neutron fission, passive neutron counting techniques, self-indication techniques for DIA applications, transport theory calculations and analysis techniques, auxiliary assay techniques using fission delayed gamma rays, neutron multiplication effects in active interrogation methods, delayed gamma rays from fission, N-6 accelerators and neutron sources, parallel computational program, and a mobile safeguards assay laboratory. (M.C.G.)

18902 (LYCEN–6957) USE OF RADIOACTIVE METHODS FOR THE DETERMINATION OF TRACES. Tousset, J. (Lyon Univ. (France). Institut de Physique Nucleaire). 9 Dec 1969. 11p. (In French). (CONF-691118–1). Dep. CFSTI (U. S. Sales Only).

From Conference on the Modern Method of Analysis of Traces, Grenoble, France.

The various radioactive techniques used for the determination of traces are reviewed. They include methods based on nuclear reactions (activation analysis and detection analysis of the emitted particles) and methods using radioactive tracers (methods with isotopic tracers, methods with radioactive reagents, and radiometric titrations). The advantages and disadvantages of the methods are discussed. (France)

18903 TRITIUM DETECTION BY β-RADIOLUMINESCENCE IN STANDARD MEDIA FOR THIN-LAYER CHROMATOGRAPHY. II. A FURTHER STUDY OF THE SENSITIVITY ENHANCEMENT AND OTHER PROPERTIES OBTAINED BY VARIOUS SCINTILLATOR ADMIXTURES. Prydz, S.; Meloe, T. B.; Eriksen, E. L.;

Koren, J. F. (Univ. of Oslo). J. Chromatogr.; 47: 157-75 (4 Mar 1970).

Results are reported concerning detection of radionuclides by thin-layer chromatography using electron-induced luminescence in added scintillators. Photoelectric detection has been applied. This method is faster than other ones based on direct electron detection and is much more accurate than photographic detection. It is therefore better suited for quantitative measurements. Relative luminescence efficiencies have been estimated for several commercial scintillators, and, for some, detailed information based on performances under ordinary conditions for measurement has been obtained. A basis for the comparison of different methods of measurement emerges from a brief discussion of such terms as sensitivity of detection and minimum detectable activity. (auth)

18904 YADERNOFIZICHESKIE METODY ANALIZA MINERAL'NOGO SYR'YA. (Nuclear Physics Methods for Mineral Ore Analysis). Yakubovich, A. L.; Zaitsev, E. I.; Przhiyalgovskii, S. M. Moscow; Atomizdat (1969). 416p.

Physical bases of the analysis methods and the principles on which the equipment is based are stated. Possibilities of using this method for analysis of mountainous rocks, ores, and products from treatment of these materials are discussed. The methods described include: radiometric analysis of radioactive ores, activation analysis, methods of analysis based on recording radiations from nuclear reactions, and methods of analysis based on absorption or dispersion of radiation in the material. A detailed description is also given of roentgenoradiometric analysis. (tr-auth)

18905 AGE OF THE CAPE KENNEDY BARRIER-AND-LAGOON COMPLEX. Osmond, J. K.; May, James P.; Tanner, W. F. (Florida State Univ., Tallahassee). J. Geophys. Res.; 75: 469-79(10 Jan 1970).

Thorium and uranium isotopic analyses of both modern and fossil shells and beach rock of the Cape Kennedy, Florida, area suggest that the materials can be treated as closed, datable systems that have experienced a brief open period after deposition (but before burial) during which both uranium and thorium were incorporated. An isochron method of correction for addition of ^{230}Th is applied, based on results from the modern materials. Two periods of deposition before the present are indicated: one at about 110 thousand years ago, and another, less extensive, at about 30 thousand years ago. These deposits appear to represent the only high sea level stands of the Pleistocene in the area. (auth)

18906 NATURAL TRITIUM ENRICHMENT FOR ANALYSES BY MEANS OF PALLADIUM FRONTAL CHROMATOGRAPHY. Tistchenko, Serge; Dirian, Gregoire (CEA, Saclay, France). Bull. Soc. Chim. Fr.; 1: 16-18(Jan 1970). (In French).

A tritium enrichment method is suggested for sample analysis. This method involves frontal chromatography, on palladium, of hydrogen obtained from water reduction. Effluent gas concentration profiles carried out with a large range of the initial isotope concentrations show that a substantial fraction of the tritium (or deuterium) present in the sample can be concentrated. Large-scale operations could concentrate 58% of the tritium contained in 115 liters of hydrogen into a 50 cm^3 volume and lead to enrichments with a factor of 1,300. (France)

18907 RADIOCHEMICAL DETERMINATION OF ^{137}Cs, ^{89}Sr, ^{90}Sr, AND ^{140}Ba IN MILK AND BONE ASH. Senegacnik, M.; Paljk, S.; Kristan, J. (Univ. of Ljubljana, Yugoslavia). Z. Anal. Chem.; 249: 39-41(22 Jan 1970).

A method for the determination of radiocaesium, radiostrontium, radiobarium in milk and bone ash is described. An alkaline fusion of ash followed by leaching with water provides for the preliminary separation of radiocaesium. After dissolution of leaching residue in hydrochloric acid and sorption on Dowex 50 W, X-8, radioyttrium (rare earths fission products), magnesium and calcium are eluted with 1.0 M ammonium lactate, pH 7.5. Radiostrontium, radiobarium, and radium are separated by elution with 0.15 M ammonium citrate, pH 7.5. ^{137}Cs is isolated as Cs-dipicrylaminate, $^{89}Sr/^{90}Sr$ as $SrCO_3$, ^{140}Ba as $BaCaCO_3$ and counted on a low-background beta-counter. For determined radionuclides the average chemical yields amount to ~80%. The limits of detection for ^{137}Cs, ^{90}Sr, ^{140}Ba are ~0.02 pCi/g with a 10 g sample of milk ash and ~0.04 pCi/g with a 4 g sample of bone ash, respectively. (auth)

18908 DIRECT MEASUREMENT OF THE ACTIVITY OF ^{131}I FROM THE AQUEOUS PHASE FOLLOWING ISOTOPE EXCHANGE WITH A LIQUID SCINTILLATOR. Zaduban, M.; Stollarova, N.; Palagyi, S. (Safarik Univ., Kosice, Czech.). Radiochem. Radioanal. Lett.; 3: 129-34(12 Mar 1970).

The separation of radioiodine from the aqueous phase in a liquid scintillator containing dissolved iodine was investigated. If the concentration gradient shows a high value, i.e., carrier-free radioiodine, or radioiodine with trace amounts of ^{127}I in the aqueous phase, the separation of radioiodine can be performed by means of rapid isotope exchange. The method proves to be effective because of its high value of detection efficiency of 100% and isotope exchange efficiency of 92.07 ± 0.73%. (auth)

18909 DETERMINATION OF ^{226}Ra AND ^{90}Sr IN BIOSAMPLES ENRICHED BY CALCIUM PHOSPHATES. Gimmel'farb, F. B. Radiokhimiya; 11: 723-6(1969). (In Russian).

A plan is proposed for the simultaneous isolation of ^{226}Ra and ^{90}Sr from one biosample enriched with calcium phosphate. The type of distribution of concentrations of ^{226}Ra and ^{90}Sr in bones of fish was established. (tr-auth)

18910 AN AUTOMATIC GLPC APPARATUS FOR THE ANALYSIS OF ORGANIC COMPOUNDS LABELED WITH SHORT-LIVED RADIOISOTOPES. Welch, M. J.; Withnell, R.; Wolf, A. P. (Brookhaven National Lab., Upton, N. Y.). Chem. Instrum.; 2: 177-88(Oct 1969).

A combined gas-liquid chromatograph, effluent counter, effluent flowmeter, and automatic data collection device is described which can be used for the analysis and assay of gas mixtures containing isotopes of short half-life. The data are collected in a form compatible for computer correction and evaluation. An example using ^{11}C-containing compounds is given. The device is useful for research with organic compounds and inorganic gases containing such isotopes as tritium, ^{11}C, ^{14}C, ^{13}N, ^{15}O, most of the active halogens, ^{31}Si, and ^{32}P. Some ^{35}S-containing compounds can also be studied. (auth)

18911 PREPARATION OF SAMPLES FOR LIQUID SCINTILLATION SPECTROMETRY. Stanley, P. E. (Waite Agricultural Research Inst., Glen Osmond, Australia). At. Energy Aust.; 13: 29-35(Jan 1970).

A brief account is given of the methods available for preparing samples for liquid scintillation counting, including both homogeneous and heterogeneous systems. The usefulness of Cherenkov counting is also discussed. (Australia)

18912 RADIOCHEMICAL ENDPOINT-DETECTION OF PARTITION TITRATIONS. Behrends, K. (Johannes-Gutenberg-Univ., Mainz). Z. Anal. Chem.; 248: 307-10(1969). (In German).

Simple methods for the detection of the equivalence point of partition titrations by means of radioactive indicators are described. No separation is required by making use of the geometry effect of γ emitters. The application of β emitters is based on the quenching of the fluorescence of liquid scintillators in the aqueous phase. (auth)

18913 THE DETERMINATION OF BURN-UP OF NUCLEAR FUEL BY RADIOCHEMICAL METHODS. Krtil, J.; Moravec, A.; Mencl, J. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett.; 3: 193-9(28 Mar 1970).

New separation methods for ^{137}Cs, ^{144}Ce, and ^{95}Zr and for the measurement of γ activity on a Ge(Li) detector for burnup analysis are described. (auth)

Activation Procedures

Refer also to abstracts 19032 and 19977.

18914 (CEA-R-3917) DETERMINATION OF RARE EARTHS IN PLANTS USING RADIOACTIVATION METHODS. APPLICATION OF THE METHOD IN GEOCHEMICAL ECOLOGY. Danne, Robert; Fourcy, Andre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan 1970. 23p. (In French). Dep. CFSTI (U. S. Sales Only).

A radioactivation method for the determination of rare earth elements in walnut leaves (Juglans nigra) and in aerial organs of Cladium Mariscus was developed. Ashed plant material is irradiated for 96 hr by a 2×10^{13} neutron s^{-1} cm^{-2} thermal flux in a swimming pool-type reactor. The rare earth group is separated from the solution by precipitation in liquid ammonia, then radiochemically purified by a first sequential chromatography on cationic resin. Rare earth elements are separated by a second chromatography on cationic resin using α-hydroxyisobutyric acid. The different elements are analyzed in γ spectrometry by comparison with a standard identically activated. Amounts of lanthanides lower than the ppM range can be determined with a satisfactory accuracy. Results show that the absolute levels of rare earth elements in plants are different; yet, the relative distributions of rare earth elements are nearly identical. (France)

18915 STUDY OF THE PHOTOACTIVATION ANALYSIS: DETERMINATION OF ARSENIC AND NIOBIUM. Oka, Yoshinaga; Nomura, Koichi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 122-7(Jun 1969). (In Japanese).

In the determination of As by comparison with an internal monitor, Se, the photopeaks of 0.511, 0.596, and 0.635 MeV from ^{74}As cannot be separated using a NaI(Tl) detector, but a Ge(Li) detector does separate the peaks. A value of $(2.02 \pm 0.03) \times 10^{-2}$ was obtained for the ratio $R_W/R_{A\theta}$ where $R_{A\theta}$ represents the ratio of the photopeaks area of 0.596 MeV from ^{74}As to that of 0.559 MeV from ^{76}As and R_W represents the mixing ratio. In the determination of Nb by comparison with an internal monitor Mo after irradiation with 17 MeV bremsstrahlung, the peaks observed were 0.943 MeV for ^{92m}Nb produced from Nb, 0.235 MeV from ^{95m}Nb, and 1.092 MeV from ^{96}Nb produced from Mo. Values of the ratio, $R_W/R_{A\theta}$, of $(4.59 \pm 0.12) \times 10^{-3}$ and $(1.66 \pm 0.04) \times 10^{-3}$ were obtained for the comparison of $^{92m}Nb/^{95}Nb$ and $^{92m}Nb/^{96}Nb$, respectively. The possibility of photoactivation of Mn, Mg, Cu, Zn, and Al was investigated using a Pt converter of 3 mm thickness. The energy spectrum of bremsstrahlung was scarcely varied by the Pt converter, and the possibility of interferences from reactions due to secondary neutrons must be considered. (NSA of Japan)

18916 ANALYSIS WITH A NEUTRON GENERATOR. Bone, S. J.; Grieg, R. A.; Porritt, R. E. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). At. Energy Aust.; 13: 24-8(Jan 1970).

The production of neutrons is outlined and the scope of the neutron generator's applications in chemical analysis is discussed, it being considered practical to assay only light elements ($Z < 20$) that are present in macroscopic amounts (>1%). A large number of routine assays of the same type of material is required. (Australia)

18917 DETERMINATION OF SODIUM AND MANGANESE IN PETROLEUM-DISTILLATION RESIDUES BY MEANS OF ACTIVATION ANALYSIS. Palmai, Gyorgy; Vajta, Laszlo; Szebenyi, Imre; Toth, Geza (Technical Univ., Budapest). Period. Polytech. Chem. Eng.; 13: No. 1-2, 99-104(1969). (In Hungarian).

The nuclear reactions employed in the tests described were $^{23}Na(n,\gamma)^{24}Na$ and $^{55}Mn(n,\gamma)^{56}Mn$, with effective cross sections of 0.525 and 13.3, respectively. The samples were irradiated with 2 to 9×10^{10} n/sq cm, and the areas under the photopeaks of 1.368 and 0.845 MeV (for sodium and manganese, respectively) were measured. The method is convenient and accurate (highest sensitivity is 0.5 ppM for sodium and 0.01 ppM for manganese). (JPRS)

18918 A CONVENTIONAL METHOD FOR 2.8 MeV NEUTRON FLUX MEASUREMENT. Weber, G.; Guillaume, M. (Univ., Liege). Radiochem. Radioanal. Lett.; 3: 97-101(12 Mar 1970).

In order to make it easier to compare the results and sensitivities obtained in different laboratories using the 2.8-MeV neutron activation analysis, a conventional method to determine the relative 2.8-MeV neutron flux is proposed. This method, similar to that used for 14-MeV neutrons, calls upon the reaction $^{115}In(n,n')^{115m}In$ which presents a threshold at 0.360 MeV and an activation cross-section of 360 mb at 2.8-MeV neutron energy. (auth)

18919 QUANTITATIVE DETERMINATION OF CONTENT OF GOLD IN CERTAIN FAULTS BY THE NEUTRON ACTIVATION METHOD. Veridze, G. I.; Macharashvili, G. R.; Mosulishvili, L. M. Radiokhimiya; 11: 726-8(1969). (In Russian).

Results obtained on the determination of trace amounts of gold in certain Georgian faults are given. The amount of gold in red faults was significantly above that in white. (tr-auth)

18920 DETERMINATION OF PALLADIUM IN MOLYBDENUM BY NEUTRON ACTIVATION ANALYSIS. Fedoroff, Michel (Centre National de la Recherche Scientifique, Vitry, France). Compt. Rend., Ser. C.; 170: 486-7(2 Feb 1970). (In French).

The radiochemical purification of palladium is necessary in order to obtain a sufficient sensitivity. The separation process comprises two steps: ion exchange on a cationic resin in NH_4OH medium containing H_2O_2 followed by a precipitation by the dimethylglyoxime in acid medium. The best sensitivity for the detection can be obtained by measuring β^- decay or x radiation. (auth)

18921 NON-DESTRUCTIVE TECHNIQUES IN ACTIVATION ANALYSIS. Ehmann, W. D. (Univ. of Kentucky, Lexington). Fortschr. Chem. Forsch.; 14: 49-91(1970).

A review of some of the more recent developments in the use of activation techniques for the essentially nondestructive determination of elemental or isotopic abundances is presented. Some of the nondestructive activation methods reviewed are 14-MeV neutron activation analysis; use of Ge(Li) detectors for multi-element trace analysis; applications of gamma-gamma coincidence spectrometry; photoactivation analysis; charged particle activation analysis; prompt gamma-ray analysis; and neutron activation followed by delayed neutron counting. (D.H.M.)

18922 ACTIVATION ANALYSIS FOR OXYGEN WITH THE HELP OF TRITONS. De Goeij, Jeroen Joannes Maria. Delft, Netherlands; Technische Hogeschool (1970). 156p. (In Dutch). Thesis.

The determination of oxygen by indirect neutron activation is described. In the method used, the sample is mixed with ^6Li, which produced tritons by neutron capture. Subsequently the tritons interact with ^{16}O giving radioactive ^{18}F. A short review of the current methods (radiochemical as well as nonradiochemical) for the determination of oxygen is given, along with a historical survey of the activation analysis of oxygen by means of reactor-generated tritons. Physical factors that may affect the accuracy and the sensitivity of the triton activation of oxygen are discussed, along with the concept of the integral cross section, in which the range of tritons plays an important part. The usefulness of the triton activation on the basis of a number of practical problems is illustrated. A determination of bulk oxygen was carried out for reduced graphite oxide and aluminum fluoride samples. Several Li–Mg–Al alloys were analyzed for surface and bulk oxygen contents. For a polyethylene sample the surface oxygen concentration was determined. For each determination a calculation of the sensitivity limits under the given circumstances is presented. (106 references). (P.C.H.)

18923 ACTIVATION METHOD FOR ZINC DETERMINATION IN IGNEOUS ROCKS. Babaev, A.; Babakhodzhaev, S. M.; Khaidarov, A.; Khudoiberganov, U. Dokl. Akad. Nauk Tadzh. SSR; 12: No. 9, 24-7(1969). (In Russian).

The content of zinc in igneous rocks of Northern Tadzhikistan was determined by neutron activation analysis with a sensitivity of 10^{-5} g. (R.V.J.)

18924 NEUTRON ACTIVATION ANALYSIS OF TRACE ELEMENTS IN SKIN. III. ZINC IN NORMAL SKIN. Molokhia, Mohamed M.; Portnoy, Benjamin (Manchester and Salford Hospital for Skin Diseases, Manchester, Eng.). Brit. J. Dermatol.; 81: 759-62(Oct 1969).

A neutron activation technique is described for analysis of samples of normal epidermis and dermis for their Zn content. Specimens of abdominal wall skin were obtained at autopsy from adults, less than 10 mg of dried material being required for analysis. The samples were weighed in small polythene bags, subsequently heat sealed, and a Zn standard and the samples were irradiated inside a Pye-A.F.M. reactor for 1 hr at a thermal neutron flux of 1.2×10^{12} neutrons $cm^{-2}sec^{-1}$. The radiochemical separation of Zn was necessary, and for complete destruction of the organic matter of skin, the samples were digested in a mixture of H_2SO_4–HNO_3 in the presence of 10 mg of Zn carrier. The radiochemical purity of the separated product, examined by half-life measurements and by γ spectrometry, was found to be satisfactory. Samples were counted by an end-window G-M counter and their β activities compared with that of the standard. In normal skin from 36 cadavers the ratio between epidermal and dermal Zn concentrations was found to be about 6:1. This gradient in Zn levels between the epidermis and dermis plus the remarkably narrow range of values found in the 2 structures suggest that Zn plays an important role in the metabolism of human skin. (BBB)

18925 AN IRRADIATION, TRANSFER, AND COUNTING SYSTEM FOR NEUTRON ACTIVATION ANALYSIS OF SHORT-LIVED COMPONENTS IN INHOMOGENEOUS SAMPLES. Priest, Homer F.; Burns, Forrest C.; Priest, Grace L. (Army Materials and Mechanics Research Center, Watertown, Mass.). Anal. Chem.; 42: 499-503(Apr 1970).

A system is described which gives uniform, reproducible irradiation of samples to be analyzed by neutron activation using a 14-MeV neutron generator. The system simultaneously rotates, revolves, and traverses both an unknown and a standard sample past the target of the neutron generator, and then transports the samples at completion of irradiation to a remote counting station where the samples are removed from the irradiation capsules and counted. Data are given to show uniformity of irradiation and precision obtained in the analyses for oxygen in a series of NBS standard reference metal samples. (auth)

18926 RADIUM AND URANIUM CONTENTS OF STANDARD ROCKS. Nishimura, Susumu (Univ. of Osaka Prefecture, Sakai City, Japan). Chem. Geol.; 5: 139-41(Nov 1969).

The 6 U. S. Geological standard rocks together with JG-1, is-

sued by the Geological Survey of Japan, were analyzed with a neutron activation technique and a radon method, and the results for each rock are tabulated. For the determination of the Ra contents of the rocks, each sample, about 5 g of acid and intermediate rocks or about 10 g of basic and ultrabasic rocks, was pulverized and dissolved with HF and HNO_3. After dehydrating, HCl was added to convert to chlorides and the solutions were diluted to volume. After sufficient time for equilibrium, the solutions were boiled, and the Rn was carried into an ionization chamber by N_2. The ionization current, resulting from the radioactivity of the Rn and its decay products, was measured by a vibrating reed electrometer. For the determination of the U contents of the rocks, the samples and monitors, sealed in separate silica tubes, were placed side by side in an aluminum container, which was irradiated for 10 hr in a reactor in a thermal neutron flux of 2×10^{13} n/cm^2 per sec. The Cd ratio was used to correct for the effect of fast neutrons. The α spectrometric assay of ^{239}Pu was done twice, about one mo and 9 mo after irradiation. The results are compared with the Ra contents obtained by the Bureau of Standards, and the U contents with various earlier reports. (BBB)

18927 DETERMINATION OF OXYGEN IN SODIUM BY PHOTON ACTIVATION ANALYSIS. Lutz, G. J. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 42: 531-2(Apr 1970).

A method for the determination of oxygen in sodium by high-energy photon activation and a rapid separation of the resulting radioactive oxygen is described. Etching of the sample after irradiation, but before separation and counting, assures removal of surface contamination. The separation involves dissolution of the sodium sample in a dilute sodium hydroxide solution under nitrogen. The radioactive oxygen, present as Na_2O, is converted to NaOH and exchanges with the water. A portion of the water is rapidly distilled from the mixture and counted by coincidence spectrometry. Samples of two grams in mass can be analyzed and, therefore, a sensitivity of less than 2 ppM at the available beam current is obtained. (D.H.M.)

18928 APPLICATION OF A LIQUID HELIUM CRYOSTAT IN NEUTRON ACTIVATION ANALYSIS OF FLUIDS. Brune, Dag; Wenzl, Helmut (Technical Univ., Munich). Anal. Chem.; 42: 511-12(Apr 1970).

The feasibility of using a liquid helium cryostat inserted in a medium flux reactor, to facilitate the low-temperature irradiation of small aqueous samples in connection with trace element analysis was studied. The heat absorption and transfer processes in the frozen samples were treated in connection with activity transport to the sample surface possibly produced by an increase in temperature. In the solution of the enzyme Stellacyanin, a copper content of 0.89 ± 0.08 μg was measured in samples with volumes of 10 μl. The conversion of liquids into frozen droplets for purposes of neutron activation may also be applied to advantage in the analysis of organic fluids such as oils. In addition, the techniques may also be utilized in the determination of neutron cross sections of nuclides with high absorption probabilities. (D.H.M.)

18929 THERMAL NEUTRON ACTIVATION OF ADHESIVE TAPES. Neely, G. W. (Los Alamos Scientific Lab., N. Mex.). Health Phys.; 18: 285-6(Mar 1970).

Materials irradiated in nuclear reactors are often held in position by adhesive tape, which becomes radioactive and may create a health physics hazard. A variety of tapes was irradiated for 1 min in a thermal neutron flux of 4×10^{13}n/cm^2/sec in the thermal column rabbit irradiation facility of the Omega West Reactor at Los Alamos and γ-ray surveys of the tapes were made immediately following and 1 hr after irradiation. Wide variations of activity were found (shown tabulated). One month after irradiation the activity of the samples was less than 0.05 mR/hr. Individual radioisotopes present were also investigated at 1 hr, 24 hr and 1 month (also shown tabulated). The results obtained should be useful in the selection of a tape that will show minimal neutron activation or in which no long-lived isotopes will be present. (UK)

18930 RADIOCHEMICAL SEPARATION AND DETERMINATION OF CADMIUM FROM BIOLOGICAL MATERIALS BY SOLVENT EXTRACTION. Hahn, Henry K. J.; Sullivan, John L.; Biotcky, Alan J.; Arsenault, Lawrence J.; May, Arthur D. (Veterans Administration Hospital, Omaha). Radiochim. Acta; 13: 55-6(Feb 1970).

A method is described for the determination of Cd in biological materials by neutron irradiation and radiochemical separation of the cadmium by extraction with dithizone in benzene. If Ag, Hg, or Cu are present additional extraction procedures are necessary to prevent their interference. The sensitivity of the method was 10^{-7} g. Human kidney tissues were analyzed for practical application of the method. (B.L.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 18908, 19035, 19053, 19057, 19071–19073, 19082, 19260, 19451, 19452, 19478, 19507, 19531, and 19998.

18931 (COO-716-52) EUROPIUM BROMIDES AND HYDRATED BROMIDES. Eick, Harry A.; Haschke, John M. (Michigan State Univ., East Lansing. Dept. of Chemistry). 30 Dec 1969. Contract AT(11-1)-716. 12p. (CONF-700403-3). Dep. CFSTI.

From 8th Rare Earth Conference, Reno, Nev.

Europium dibromide was prepared by dehydration and decomposition of an europium tribromide hexahydrate–ammonium bromide matrix and single crystals were grown by vapor transport techniques. Anhydrous europium tribromide was prepared by reaction of the dibromide with bromine at bromine pressures of between 12 and 70 atm. Powder and single crystal x-ray-diffraction data indicate tetragonal symmetry for $EuBr_3$ ($a = 11.574 \pm 0.006$, $c = 7.098 \pm 0.005$ Å) and orthorhombic symmetry for $EuBr_3$ ($a = 9.12 \pm 0.01$, $b = 12.66 \pm 0.02$, $c = 4.013 \pm 0.005$ Å). Monoclinic $EuBr_3 \cdot 6\,H_2O$ ($a = 10.025 \pm 0.008$, $b = 6.757 \pm 0.005$, $c = 8.164 \pm 0.007$ Å, $\beta = 93.48 \pm 0.06°$) and orthorhombic $EuBr_2 \cdot H_2O$ ($a = 11.46 \pm 0.02$, $b = 4.291 \pm 0.005$, $c = 9.20 \pm 0.01$ Å) were also characterized. Observed and calculated x-ray-diffraction powder intensities for the europium dibromide structure are presented and discussed. The data are compared with that of strontium dibromide. (auth)

18932 (COO-890-7) PYROLYTIC RADIOGAS CHROMATOGRAPHY OF ^{14}C AND TRITIUM LABELED 1-HEXENES. Shepherd, Sandra Ann (Illinois Univ., Urbana). 1968. 98p. Dep. CFSTI.

Thesis.

Pyrolytic radiogas chromatography was used to investigate the pyrolysis of carbon-14- and tritium-labeled 1-hexenes. Under standard thermolytic conditions the cracking patterns obtained by this method are reproducible to within ±10% for 1- to 4-mg samples containing 5.0 μCi/mmole or more carbon-14 or tritium. These degradation patterns are directly related to the labeling in the parent compound. The method of pyrolytic radiogas chromatography can therefore be used to determine the position of carbon-14 or tritium labeling in olefinic compounds with analysis times of less than one hour compared to the weeks required for similar determinations by chemical degradation. Because the cracking patterns of the radioactive 1-hexenes were isotopically reliable, the degradation patterns of n-hexane-1-T and selected alcohols were studied. In addition, the mechanism of the degradation of the alcohols was postulated to be a free radical process with initial cleavage to give the hydroxymethylene radical, which subsequently decomposed to carbon monoxide. (auth)

18933 STIMULATED RAMAN SPECTRA FROM H_2O, D_2O, HDO, AND SOLUTIONS OF $NaClO_4$ IN H_2O AND D_2O. Colles, M. J.; Walrafen, G. E.; Wecht, K. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Chem. Phys. Lett.; 4: 621-4(1 Feb 1970).

Stimulated Raman spectra were obtained from H_2O, D_2O, H_2O–D_2O mixtures, and solutions of $NaClO_4$ in H_2O and D_2O using picosecond pulse excitation at 530.0 nm. The stimulated emission peaks could be predicted from the spontaneous Raman contour shapes for the OD stretching vibrations, but exclusive stimulation of either hydrogen-bonded or of nonhydrogen-bonded components was observed for the OH stretching vibrations. The large widths of the stimulated spectra are discussed in relation to self-focusing and refractive index modulation. (auth)

18934 AN EFFUSION STUDY OF THE REACTION OF ZIRCONIUM CARBIDE WITH CALCIUM OXIDE. Rai, Juey Hong; Gregory, N. W. (Univ. of Washington, Seattle). J. Phys. Chem.; 74: 1076-82(5 Mar 1970).

Pressure-time studies of the reaction of CaO with ZrC in effusion cells indicated that the rate of reaction is controlled by diffusion of reactant ions through the product layer of $CaZrO_3$. Extrapolation back to time zero gave total effusion pressures in general agreement with those expected for the reaction $ZrC(s) + CaO(s) = CaZrO_3(s) + 3Ca(g) + CO(g)$ at equilibrium. The behavior of ZrC samples of different carbon content was reported. Experiments on the reaction of ZrO_2 with graphite are also described. (auth)

18935 ISOTOPIC EXCHANGE IN THE SYSTEM $[PbCl_{4+q}^{(q-4)-}$–$^{36}Cl_{aq}^-$. Szychlinski, Jerzy; Kolankowski, Stanislaw; Poniewozik, Aleksander (Ecole Normale, Danzig). Zesz. Nauk. Mat., Fiz., Chem., Wyzsza Szkola Pedagog. Gdansku; 8: 207-12(1968). (In Polish).

The exchange of ^{36}Cl between $[PbCl_{4+q}^{(q-4)-}$ and the simple chloride

ion was investigated. It was established that in aqueous solutions this exchange occurs very rapidly, which proves that the Pb–Cl bonds are very polar in these complexes. In the two-phase system $(NH_4)_2PbCl_{6(s)} - [PbCl_n]^{(n-4)-}$ the rate of exchange attains such a value that it can be obtained easily from kinetic measurements. At equilibrium in the systems examined an appreciable isotopic effect was observed, expressed by a specific activity of the chloride in solution of twice that found in the precipitated $(NH_4)_2PbCl_6$. (tr-auth)

18936 CHELATE EQUILIBRIA OF QUINQUEVALENT TRANS-URANIUM ELEMENTS WITH AMINOPOLYCARBOXYLIC ACIDS. Eberle, S. H.; Wede, U. (Univ., Karlsruhe, Ger. Kernsforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem.; 32: 109-17(Jan 1970). (In German).

With aliphatic aminopolycarboxylic acids, pentavalent actinides form protonated and normal chelates of 1:1-stoichiometry. In addition, at high pH chelate hydroxides with one ligand molecule and one hydroxyl group per atom are formed. Higher chelates were not found. The nature of the ligand has only small or no influence on the stability constants of normal chelates or chelate hydroxides, respectively. It is suggested, that not more than two carboxylic groups and one amine-nitrogen are bound from one ligand to the central atom. The chelate hydroxides, and probably also the protonated and normal complexes of MO_2^+-cations, have the coordination number four. (auth) (UK)

18937 FLUORO COMPLEXES OF URANIUM(IV). Satpathy, K. C. (G. M. Coll., Sambalpur, India); Sahoo, B. J. Inorg. Nucl. Chem.; 32: 549-53(Feb 1970).

Photolysis of aqueous solutions of hydrazine uranyl fluoride complexes, $UO_2F_2(N_2H_4HF)_3\ 1.5H_2O$ and $UO_2F_2(N_2H_4 2HF).H_2O$ yields $N_2H_5UF_5$ and UF_4H_2O, respectively. A number of fluoro complexes with organic bases such as primary aliphatic amines, primary aromatic amines, pyridine, substituted pyridines and quinoline were also synthesized. These complexes possess the general formula $[RH^+]\ [UF_5^-]nH_2O$, where R represents either an amine or a pyridine group. The complexes are nonhygroscopic, sparingly or moderately soluble in water, but insoluble in common organic solvents, and can be stored for several days without appreciable oxidation. (auth) (UK)

18938 ISOINVERSION IN HYDROGEN ISOTOPIC EXCHANGE REACTIONS. Wong, Siu-May Cheng. Los Angeles; Univ. of California (1969). 122p.

Thesis.

The stereochemical course of the base-catalyzed hydrogen-deuterium exchange reactions at saturated carbon was studied with (-)-3,3,3-triphenyl-2-methylpropionitrile (I) in various solvent-base systems. The relative ratios of the exchange reaction (rate constant k_e) and of racemization (rate constant k_α) were measured from competitive experiments, and the ratios of k_e/k_α were used as a criterion of steric course. A value of k_e/k_α larger than 1 indicates exchange with retention of configuration. If k_e/k_α is 1, the exchange proceeds with net racemization. A value of k_e/k_α between 1 and 0.5 can indicate exchange with inversion. If k_e/k_α is less than 0.5, the substrate is undergoing isoracemization, defined as racemization without exchange. The process by which a carbon acid is converted to its enantiomer without isotopic exchange is defined as isoinversion. With I, values of k_e/k_α ranging from 0.2 to 1 in various solvents were obtained. The kinetic model developed by Cram and co-workers was employed in the analysis of the overall stereochemical course of base-catalyzed hydrogen-deuterium exchange of I in terms of mechanistic components. Rate constants for exchange with retention, exchange with inversion, and isoinversion were determined by the reresolution method for exchange of I in t-butyl alcohol-O-d with potassium t-butoxide, with or without cyclic polyether 2,5,8,15,18,21-hexaoxatricyclo [20.4.0.0^{9,14}]hexacosane (II), in t-butyl alcohol-O-d with pentamethylguanidine and in dimethyl sulfoxide with DABCO. In all of the above media, except the one with cyclic polyether II, isoinversion was shown to be an important mechanistic component. The result is interpreted in terms of ion pair formation, reorganization, collapse, and dissociation. (Diss. Abstr. Int., B)

18939 DISSOLUTION OF U_3O_8 WITH H_2SO_4 AND Fe^{3+} IONS AS OXIDIZER. Saracco, Giovanni Battista; Piccinini, Norberto (Politecnico, Turin). Ann. Chim. (Rome); 59: 997-1012(1969). (In Italian).

The experimental dissolution of U_3O_8 in H_2SO_4 in the presence of ferric ions under various conditions of Fe^{3+}, Fe^{2+}, SO_4^{2-}, concentration, pH, and temperature is reported. A common feature of all tests was the tendency of the dissolution rate to reach a constant level, after an initial period, and then remain unchanged almost until the dissolution was completed. Attack rate mechanism and this reaction behavior pattern are discussed with reference to recent views concerning redox mechanisms, and it was concluded that the controlling agent in this case was of type $(H_2O)_4\ FeX^{2+}$, where $X = \frac{1}{2}\ SO_4^{2-}$; due to rapid formation reaction and of equilibrium with other molecular agents, the concentration of this agent was presumed to remain constant and very low. By slowly oxidizing the U^{4+} ions on the surface of the U_3O_8 granules, the agent renders both these and their bonded U^{4+} ions more open to attack by H_2SO_4. (auth)

18940 KINETICS OF ION EXCHANGE. DIFFUSION OF TRACE COMPONENT. Sharma, H. D. (Univ. of Waterloo, Ont.); Jervis, R. E.; McMillen, L. W. J. Phys. Chem.; 74: 969-78(5 Mar 1970).

The diffusion of Cs^+, Co^{2+}, La^{3+}, Tb^{3+}, and Lu^{3+} ions in ion-exchange beads has been studied in the presence of a large excess of another counterion. The rate laws for the uptake of ions present in trace concentration have been verified, and the agreement between the theory and the experimental results is very good, if contributions due to both film and particle diffusional processes are taken into account. The criteria for distinguishing between "film" and "particle" diffusion-controlled mechanisms have been examined. The $\bar{D}$ values for Cs^+, Co^{2+}, and La^{3+} in 1 M HCl, 0.5 M $CaCl_2$, and 0.17 M $LaCl_3$ and for Tb^{3+} and Lu^{3+} in HCl solutions indicate that large hydrated ions, having the same charge, have higher mobility inside the resin matrix contrary to the earlier concepts. The $\bar{D}$ values in methanol–water solutions show that the solvent in the resin matrix plays an important role in the transport of ions in the matrix, and thus it is difficult to compare experimentally determined interdiffusion coefficients $\bar{D}_{AB}$ with the ones predicted by Helfferich–Plesset equation because the solvent content of the resin matrix changes as the ionic composition of the matrix changes from one form to the other. (auth)

18941 NUCLEAR MAGNETIC RESONANCE PSEUDO-CONTACT SHIFTS IN U(ALLYL)$_4$. Paladino, N. (SNAM Progetti, Milan); Lugli, G.; Pedretti, U.; Brunelli, M. Giacometti, G. Chem. Phys. Lett.; 5: No. 1, 15-16(15 Feb 1970).

The ^{1}H-magnetic resonance of Uranium (IV)-tetra-allyl gave evidence of its being a π-allyl complex. The large chemical shifts observed were significantly affected by a pseudo-contact mechanism. (auth)

18942 INFRARED STUDIES ON COLLAGEN TREATED WITH METHYLOL-PHENOLS AND THEIR POLYMERIC PRODUCTS USING DEUTERIUM EXCHANGE TECHNIQUE. Saleh, M. S. E.; Srinavasan, S. R. (Alexandria Univ., Egypt. Louisiana State Univ., Baton Rouge). Ann. Chim. (Rome); 59: 1013-21 (1969).

Thin collagen films were treated with methylol phenol formaldehyde condensates, which represent the first stages in syntan production. The rate of deuterium exchange was followed by infrared spectrophotometry and the shrinkage temperature T_s of treated collagen was measured. The o-hydroxybenzyl alcohol, 2,4,6-trimethylolphenol, and phenol formaldehyde condensates showed a faster HD rate of exchange than untreated collagen indicating break up of interchain hydrogen bonds in collagen. The p-hydroxybenzyl alcohol, although it reduced the T_s of the collagen, showed a slower rate of exchange, which may be due to formation of an intrachain cross-linking. (auth)

18943 STUDIES IN SOLVOLYSIS. PART I. THE NEUTRAL HYDROLYSIS OF SOME ALKYL TRIFLUOROACETATES IN WATER AND DEUTERIUM OXIDE. Winter, June G.; Scott, J. M. W. (Memorial Univ. of Newfoundland, St. John's). Can. J. Chem.; 46: 2887-94(15 Sep 1968).

The temperature dependence of the rates of neutral hydrolysis of a series of alkyl trifluoroacetates (CF_3COOR; R = methyl, ethyl, s-propyl, t-butyl) was determined in both light and heavy water. From these studies the thermodynamic parameters ($\Delta H^{\neq}$, $\Delta S^{\neq}$) that characterize the activation process were calculated. Sufficient rate data were obtained in the case of the ethyl ester to calculate the heat capacity of activation ($\Delta C_p^{\neq}$) for the hydrolysis of this compound in light water. Both entropies and enthalpies of activation as well as the solvent isotope effects are consistent with the proposal that the primary and secondary esters react by an acyl-oxygen $B_{Ac}2$ mechanism, in contrast to the tertiary ester, which appears to react either by a carbonium ion (S_N1) process or by a route which combines both the $B_{Ac}2$ and S_N1 paths. (auth) (Canada)

18944 ISOTOPE AND SUBSTITUENT EFFECTS ON THE INTERACTION OF BENZOPHENONE WITH SIMPLE OLEFINS. APPARENT INSUFFICIENCY OF THE SCHENK MECHANISM. Caldwell, Richard A. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc.; 92: 1439-41(11 Mar 1970).

Studies were made on the isotope effect on oxetane formation in the benzophenone-sensitized cis to trans isomerization of 2-butene.

Benzophenone was irradiated in the presence of a fourfold excess of deuterium labeled 2-butene, and the resulting oxetane was analyzed mass spectrometrically for deuterium content and position. The results showed low intermolecular isotopic selectivity, which indicated essentially no isotope effects on the partitioning of the biradical in this system. The mechanism for the reaction is discussed. (P.C.H.)

18945 THE STEREOSPECIFIC ADDITION OF CARBON AND NITROGEN NUCLEOPHILES TO DICYCLOPENTADIENEPLATINUM AND -PALLADIUM COMPLEXES. Stille, John K.; Fox, Dale B. (Univ. of Iowa, Iowa City). J. Amer. Chem. Soc.; 92: 1274-8(11 Mar 1970).

The nucleophilic additions of acetylacetone, ethyl acetoacetate, diethyl malonate, or benzylamine to the double bond of dichloro (endo-dicyclopentadiene)platinum(II) and of thallous acetylacetone to dichloro(endo-dicyclopentadiene)palladium(II) produced platinum- and palladium-carbon σ-bonded complexes. The trans additions take place at the 5,6-double bond without skeletal rearrangement of the dicyclopentadiene moiety; the nucleophile is attached exo with the metal endo and coordinated to the 2,3-double bond. Deuterium exchange studies are also described. (auth)

18946 CARBONIUM IONS. XV. THE DEAMINATION OF DEUTERIUM-LABELED 1-PENTYL AND 1-HEXYLAMINES. PROTONATED CYCLOPROPANES AND INTRAMOLECULAR 1,2-HYDRIDE SHIFTS. Karabatsos, Gerasimos J.; Anand, Mona; Rickter, Donald O.; Meyerson, Seymour (Michigan State Univ., East Lansing. American Oil Co., Whiting, Ind.). J. Amer. Chem. Soc.; 92: 1254-60(11 Mar 1970).

The aqueous acid deaminations of 1-pentyl-1,1-d_2-, -2,2-d_2-, and -3,3-d_2-amine gave mixtures of pentanols, consisting of about 60% 1-pentanol, 30-35% 2-pentanol, and 5-10% 3-pentanol. Mass spectral analysis of the trimethylsilyl ether derivatives of the product 1-pentanols showed that these alcohols were exclusively isotope-position unrearranged, i.e., they had the labels at the same carbon as the starting amines. Similarly, mass spectral analysis of the trimethylsilyl ether derivative of the 1-hexanol obtained from the deamination of 1-hexyl-1,1-d_2-amine showed that this alcohol was exclusively isotope-position unrearranged. Mass spectral analysis of the trimethylsilyl ether derivatives of the secondary alcohols revealed that these alcohols were extensively isotope-position rearranged. The results have been interpreted in terms of reversible 1,2-hydride shifts with no 1,2-alkyl, or 1,3-, 1,4-, 1,5- or 1,6-hydride shifts. The secondary carbonium ion formed from the normal alkyl system undergoes only two detectable 1,2-hydride shifts, the substitution product arising from a third shift contributing less than 0.1% to the yield of secondary alcohols. These intramolecular 1,2-hydride shifts are subject to strong conformational control, they exhibit k_H/k_D isotope effects of about 1.2–1.4, and they occur faster in the smaller alkyl than in the larger systems. The last conclusion seems best interpreted in terms of different amounts of excess vibrational energy in the carbon–hydrogen bond of the migrating hydrogen. (auth)

18947 CARBONIUM IONS. XIV. EFFECT OF SUBSTITUTION AT CARBON-3 OF 1-PROPYL SYSTEM ON INTERMEDIACY OF PROTONATED CYCLOPROPANES. Karabatsos, Gerasimos J.; Mount, Ramon A.; Rickter, Donald O.; Meyerson, Seymour (Michigan State Univ., East Lansing. American Oil Co., Whiting, Ind.). J. Amer. Chem. Soc.; 92: 1248-53(11 Mar 1970).

The aqueous acid deamination of 1-butylamines labeled with two deuterium atoms at C-1, C-2, or C-3 gave a 50% mixture of butanols consisting of about 65% 1-butanol and 35% 2-butanol. The deamination of 2-butyl-2d_1-amine and 2-butyl-3,3-d_2-amine gave 2-butanol as the sole alcohol product. Mass spectral analysis of the trimethylsilyl ether derivatives of the 1-butanol products disclosed that these alcohols were exclusively isotope-position unrearranged. This finding ruled out protonated cyclopropanes as intermediates in the path of formation of 1-butanol. Mass spectral and nuclear magnetic resonance analysis of the trimethylsilyl ether derivatives of the 2-butanols obtained from the 1-butyl and the 2-butylamines disclosed that these alcohols were extensively isotope-position rearranged. The rearrangement path responsible for the isotopic scrambling was established to be reversible 1,2-hydride shifts, not involving protonated cyclopropanes. These intramolecular 1,2-hydride shifts are subject to conformational control and to k_H/k_D effects of about 1.2–1.4. A single alkyl substitution at C-3 of the 1-propyl system decreases the product yield arising via a protonated cyclopropane to the same extent as a single alkyl substitution at C-2. The overall product yield from the protonated cyclopropane path was estimated to be less than 1%. (auth)

18948 PREDICTED PROPERTIES OF THE SUPER HEAVY ELEMENTS. I. ELEMENTS 113 AND 114, EKA-THALLIUM AND EKA-LEAD. Keller, O. L. Jr.; Burnett, J. L.; Carlson, T. A.; Nestor, C. W. Jr. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 74: 1127-34(5 Mar 1970).

The probable existence of an island of nuclear stability centered on element 114 makes the prediction of chemical and physical properties of elements in this region important for their identification. These elements may be produced using proposed heavy ion accelerators, or they may even be found in nature. The values derived from extrapolations in Mendeleev's periodic system and theoretical calculations are presented in tabular form. (auth)

18949 PRECIPITATION OF PLUTONIUM(IV) MOLYBDATE. Watanabe, Kenju; Muromura, Tadasumi (Japan Atomic Energy Research Inst., Tokai). Nippon Kagaku Zasshi; 90: 1025-7 (Oct 1969). (In Japanese).

The precipitation of plutonium(IV) molybdates in acidic solutions was studied. Plutonium(IV) molybdates were precipitated by adding a solution of Pu(IV) to sodium molybdate in 0.1 to 0.3N HCl or in acetic acid–sodium acetate buffer solutions of pH 1.5 to 4.1. The composition of the precipitate was dependent on pH of the solution, concentration of sodium molybdate in the solution, and contact time of the precipitate with the mother liquor. The solubility of the precipitate corresponding to the normal molybdate, $Pu(MoO_4)_2 \cdot n\,H_2O$, was $(0.9 \text{ to } 7.5) \times 10^{-4}$ mole/l in 0.16 to 1.0N HCl at 25°C. The precipitate was decomposed at 750 to 1150°C to PuO_2 and volatile MoO_3. (NSA of Japan)

18950 MODEL SYSTEM ISOTOPE EFFECT STUDIES INVOLVING HYDRONIUM ION. Koeppl, Gerald Walter. Chicago; Illinois Inst. of Tech. (1969). 321p.

Thesis.

Kinetic protium–deuterium isotope effects were calculated within the framework of Eyring's absolute reaction rate theory on the basis of a nonlinear five-center model for hydrogen ion transfer from the hydronium ion. The model system was defined in terms of empirical relationships involving valence bond lengths, angles, force constants, and Pauling's "bond order." The results indicated that primary and secondary effects in this system were related to transition state symmetry in a different manner. Transition state symmetry in the present work is measured in terms of the parameter δ, the order of the bond in the ion acceptor (or product fragment) portion of the transition state. As δ proceeds from zero to unity (and the transition state structure proceeds from a reactant-like to a product-like limiting configuration), the primary isotope effect proceeds through a maximum value in concordance with expectation on the basis of the Westheimer theory. However, the secondary isotope effect which is associated with tightening in the transition state's nonreacting bonds, is in the inverse direction and proceeds to a minimum value. The presence of the inverse isotope effect in this system offers an explanation for the many unexpectedly low values of the overall solvent (H_2O–D_2O) isotope effect for acid catalysis via the A-S_E2 mechanism in the literature. The valence bond force constant sets adopted for the reactant hydronium ion and product water, in the model study, were chosen to generate vibrational frequencies for H_3O^+, D_3O^+, H_2O, and D_2O, which were in reasonable agreement with values appropriate for the liquid state. The multiplicative relationships among the five possible protium–deuterium kinetic isotope effects calculated on a free-rotation basis were tested and found to hold to a good approximation. The Swain–Schaad relationship between the magnitudes of protium–deuterium and protium–tritium isotope effects was tested for primary, secondary and overall free-rotation kinetic isotope effects computed with and without a moderate tunneling correction. The relationship was valid to a good approximation in all cases. Since the librational contribution factor associated with the equilibrium constant L was significant, a qualitative means of assessing the librational contribution to the kinetic isotope effects was examined. Librational modes, in general, made small contributions to the kinetic isotope effects. Assumptions associated with the theoretical treatment of both kinetic and equilibrium isotope effects in H_2O–D_2O mixtures were examined in detail. The relationship between the variation in the fractionation factors $\phi_{L_3O^+}$, ϕ_{LA} and $\phi_{LA^{\neq}}$ with solvent deuterium content and deviations from the RGM in isotopic partition function ratios was investigated via computer experiments. It is likely that $\phi_{L_3O^+}$ and $\phi_{LA^{\neq}}$ will vary to a small extent with solvent deuterium content; ϕ_{LA} does vary with solvent deuterium content to the extent of ±3% due to deviations from the RGM in the solvent. Experimental support for the model system study and Westheimer's theory was provided via the analysis of literature data for kinetic isotope effects in H_2O–D_2O mixtures, and literature results for the isotopic analyses of products for reactions of the A-S_E2 type involving the hydronium ion. (Diss. Abstr. Int., B)

18951 ELECTRON SPIN RESONANCE STUDIES OF FLUORINATED AND SOME DEUTERATED AROMATIC FREE RADICALS. Kulkarni, Shrikant Vishnu. Chicago; Illinois Inst. of Tech. (1969). 153p.

Thesis.

A systematic study of the hyperfine interactions of the fluorinated triphenylmethyl radicals and benzophenone anion radicals is presented. The fluorine splittings in substituted triphenylmethyl radicals can be satisfactorily interpreted with a two parameter equation, which includes the σ-π interactions in the C–F bond and the spin densities on the carbon and fluorine π orbitals. A consistent set of Q values, which gave very satisfactory results even in case of the fluorinated benzophenone anion radicals, was obtained. The anomalous nature of the ortho fluorine hyperfine splittings in the ortho substituted triphenylmethyl radicals could be explained by assuming a direct interaction between the ortho fluorine atoms and the spin density on the methyl carbon atom in the radical. A similar ortho effect was also noted in the case of benzophenone anion radicals, which was different in magnitude from that observed in the case of triphenylmethyl radicals. A series of deuterated triphenylmethyl radicals were studied by ESR to test the theory of deuterium isotope effect since triphenylmethyl radical provides an ideal system for such studies. The results obtained in this investigation are not consistent with this qualitative theory. (Diss. Abstr. Int., B)

18952 URANIUM(VI)–METHYLTHYMOL BLUE (PENTA SODIUM SALT) CHELATE: A SPECTROPHOTOMETRIC STUDY. Srivastava, K. C.; Banerji, Samir K. (Birla Inst. of Tech. and Science, Pilani, India). J. Prakt. Chem.; 311: 769-74(1969).

A spectrophotometric study was made of the composition and stability of the chelate formed between uranium(VI) and the penta-sodium salt of methylthymol blue (MTB). The composition of the red chelate (λ_{max} 510 nm) as established by two different methods, was found to be 1:1 (metal:chelating agent). The chelate is stable between pH 6.2 and 6.9. The average value of log K at 30° (pH 6.7 ± 0.1; μ = 0.1 M) is 5.6 ± 0.2 and $\Delta G°$ at the same temperature is −7.7 ± 0.2 kcal/mole. (auth)

18953 NMR AND STRUCTURE OF CRYSTALS OF HYDRATED URANIUM TETRAFLUORIDE. Gabuda, S. P.; Matsutsin, A. A.; Zadneprovskii, G. M. Zh. Strukt. Khim.; 10: 1115-16(Dec 1969). (In Russian).

To obtain information of the structure of UF_4 hydrates, the NMR spectra of fluorine and protons in these compounds were studied. The results obtained were in complete agreement with crystal-chemical data. The carefully expressed symmetry of the spectra obtained indicates the presence of paired linear coordination, yet, apparently, the divergence of valence angles U–F–U from 180° and the oscillation of small U–F distances. The maximum content of water in the cell of this compound is 20 molecules. (tr-auth)

18954 DETERMINATION OF THE RATE CONSTANT OF THE BRANCHING REACTION IN A RAREFIED HYDROGEN FLAME BY THE METHOD OF ISOTOPE EXCHANGE. Buneva, V. N.; Kabasheva, G. N.; Panfilov, V. N. Kinet. Katal.; 10: 1221-5(Nov-Dec 1969). (In Russian).

Analyses were carried out on kinetic equations of the oxidation of hydrogen with small additions of deuterium inside the region of combustion near the lower boundary. An equation was found that relates the formation of water and HD. The relation of constants for the rates of reaction of $H + O_2 \rightarrow OH + O$ and $H + D_2 \rightarrow HD + D$ was determined. (tr-auth)

18955 THE REACTION CAPABILITY OF OXYGEN ON THE SURFACE OF COMPLEX OXIDES. II. ISOTOPE EXCHANGE OF OXYGEN ON IRON ANTIMONY OXIDE CATALYSTS. Muzykantov, V. S.; Panov, G. I.; Boreskov, G. K. Kinet. Katal.; 10: 1270-7(Nov-Dec 1969). (In Russian).

The isotopic exchange of oxygen was studied on iron antimony oxides in all regions of composition, including individual oxides of iron and antimony, iron antimonate, and compositions that consist of two phases: antimonate and the corresponding oxide. The main kinetic characteristics of the exchange were determined and their relation to the composition of the catalyst studied. (tr-auth)

18956 MASS SPECTROMETRIC FRAGMENTATION OF 2-ISOPROPENYL-2,5-DIMETHYLCYCLOHEXANONE AND 2-ISOPROPYL-2,5-DIMETHYLCYCLOHEXANONE. Kulkarni, M. V. (Oklahoma State Univ., Stillwater); Eisenbraun, E. J.; Hamming, M. C. J. Org. Chem.; 35: 686-9(Mar 1970).

The mass spectra of six polyalkylcyclohexanones related to menthone are described. The fragmentation patterns were substantiated by deuterium labeling, exact mass measurements, and metastable ions. The McLafferty rearrangement is observed for saturated ketones, as expected, with the formation of an odd-electron ion peak at M-42. However, for the unsaturated compounds, α cleavage predominates to give an even-electron ion peak at M-43. (auth)

18957 HETEROGENEOUS REACTIONS WITH ZINC. II. A GENERAL SYNTHESIS OF KETONES FROM 1,2-TRISUBSTITUTED GLYCOL MONOESTERS AND THE MECHANISM OF THE SERINI REACTION. Ghera, E. (Weizmann Inst. of Science, Rehovoth, Israel). J. Org. Chem.; 35: 660-6(Mar 1970).

Secondary monoesters of open-chain, trisubstituted 1,2-glycols were converted into ketones on heating with zinc dust. The reaction was found valid for benzoate and p-nitrobenzoate esters, as well as for acetates, better synthetic results being obtained with the former. In the presence of aromatic substituents at the secondary carbon atom, 1,2-aryl shifts, affording aldehydes, can also take place. Reactions of trisubstituted 1,2-glycol monoesters catalyzed by anhydrous zinc acetate led to results similar to those obtained using metallic zinc. These findings, in addition to other observations disproving the previously accepted assumptions concerning the mechanism of the Serini reaction in steroid systems, support the role of the zinc catalyst as a complexing Lewis acid. The values of the isotope effects k_H/k_D observed during the rearrangements suggest the participation of the migrating hydrogen in the ionization at the tertiary carbon atom. Diastereomeric systems were used for the investigation of steric effects. (auth)

18958 A STUDY OF RADIATIONLESS TRANSITIONS IN BENZENE AND NAPHTHALENE. Watts, Richard James. Boulder, Colo.; Univ. of Colorado (1969). 158p.

Thesis.

The results of a study of several of the radiationless transitions occurring in benzene and naphthalene are reported. A study of the fluorescence spectrum of naphthalene vapor on excitation of the second excited singlet state is presented. A model is presented for the interpretation of the quenching of the fluorescence of benzene vapor by cyclohexane. This model is found to provide an adequate explanation of the available experimental data. A study of the effect of the number and position of deuterium substituents on the phosphorescence lifetime for eight different isotopic naphthalenes at 76°K is presented. It is experimentally shown that the deuterium effect on the triplet state lifetime of naphthalene is due to a change in the radiationless part of the decay rate. The radiative decay rate is independent of deuterium substitution. The study reveals a significant dependence of the rate of radiationless decay to the ground state on the positions of the protons in naphthalene. Protons in the α positions are about 1.6 times as effective as protons in the β positions in promoting radiationless transitions. A simple empirical relation is found to give a reasonable fit to the data. A small intermolecular isotope effect on the triplet state lifetime of naphthalene-d_8 in ethanol is also found upon deuteration of the solvent. The experimental results are discussed in terms of existing theories of radiationless processes. (Disser. Abstr.)

18959 THERMOGRAVIMETRY AND DERIVATIVE THERMOGRAVIMETRY. Blandenet, G.; Detheve, J.-L.; Peron, J.-P. Chim. Anal. (Paris); 50: 385-9(1968). (In French).

The advantages that derivative thermogravimetric analysis has over conventional thermogravimetric analysis are indicated, viz., the provision of more accurate kinetic curves, the accurate determination of reaction temperature, and the detection of phenomena that are completely unnoticed by thermogravimetry alone. These merits are emphasized by describing the results obtained for (i) the thermal decomposition of Ni oxalate dihydrate (pure or supported on or mixed with SiO_2–Al_2O_3) in a stream of H_2, (ii) the detection of an intermediate compound, $Th(HCOO)_4 \cdot \frac{1}{2}H_2O$ during the thermal dehydration of crystalline Th formate, (iii) the different dehydration rates of two apparently similar samples of $CaSO_4 \cdot 2H_2O$, and (iv) the decomposition of $LiIO_3$. (Anal. Abstr.)

18960 THE ACID-CATALYZED ISOMERIZATION REACTION OF TRANS-DIAQUODIOXALATOCHROMIUM(III) ANIONS IN AQUEOUS SOLUTIONS. Kelm, H.; Stieger, H.; Harris, G. M. (Univ., Frankfurt am Main. State Univ. of New York, Buffalo). Ber. Bunsenges. Phys. Chem.; 73: 939-46(Dec 1969). (In German).

The rate of isomerization of the trans-$[Cr(C_2O_4)_2(H_2O)_2]^-$ ion was studied in respect to its acid concentration dependence. While the rate constant of the reaction shows a direct proportionality to the titrimetrically determined hydrogen ion concentration up to about 0.6 molar acid, it increases more than proportionally at higher acid concentrations. Using a modified Hammett-acidity function this strong acceleration of the reaction could be explained as an acid catalysis during which the complex ion is protonated in an equilibrium preceding the rate determining step. The deuterium solvent isotope effect of the reaction and its acid concentration dependence as well as the results obtained in D_2O–H_2O mixtures and their interpretation on the basis of the Gross–Butler equation support the assumed mechanism of an acid catalysis. (auth)

18961 SMALL RING COMPOUNDS. XXV. CYCLOPROPENYL RADICAL. Shono, T.; Toda, T.; Oda, R. (Kyoto Univ.). Tetrahedron Lett.; No. 5, 369-72(Jan 1970).

A study is reported on the electrochemical formation and chemical behavior of the cyclopropenyl radical. In the course of this study the deuterium isotope effect in the hydrogen abstraction reaction of the triphenylcyclopropenyl radical from chloroform and chloroform-d, was 2.3 ± 0.16. This value is similar to that of the chlorine atom and suggests low selectivity for the cyclopropenyl radical. The deuterium isotope effect for the 2-phenylcyclopropyl radical was 2.8 ± 0.1. The studies suggested that the reactivity of the cyclopropenyl radical is similar to that of the phenyl radical. (UK)

18962 FURTHER UNUSUAL DEUTERIUM ISOTOPE EFFECTS (β VERSUS α) ON THE POLARIMETRIC RATE OF SOLVOLYSIS OF THREO-1-METHYL-2-PHENYLPROPYL TOLUENE-p-SULPHONATE AND THE QUESTION OF NON-CLASSICAL CARBONIUM ION INTERMEDIATES. Loukas, Spyro L.; Velkou, Margaret R.; Gregoriou, George A. (Greek Atomic Energy Commission, Athens). J. Chem. Soc., D; No. 4, 251-2(18 Feb 1970).

Acetolysis, formolysis, and trifluoroacetolysis of (+)-threo-1-methyl-2-phenylpropyl toluene-p-sulphonate and deuterated derivatives and gave isotope effects, k_I/k_{II} versus k_I/k_{III}, of 1.104 versus 1.094, 1.142 versus 1.040, and 1.133 versus 1.009, respectively. The results are not satisfactorily interpreted in terms of either a nonclassical symmetrical phenonium ion or two rapidly equilibrating classical carbonium ions, but are claimed to be understandable in terms of a third model. (auth) (UK)

18963 HYDROGEN ISOTOPIC EXCHANGE IN FIVE-MEMBERED AROMATIC HETEROCYCLES. II. 2- AND 3-SUBSTITUTED THIOPHENES. Zatsepina, N. N.; Kaminskii, Yu. L.; Tupitsyn, I. F. (State Inst. of Applied Chemistry, Leningrad). Reakts. Sposobnost Org. Soedin., Tartu Gos. Univ.; 6: 448-57 (Jun 1969). (In Russian).

The kinetics of deuterium exchange in 2- and 3-substituted thiophenes was studied in O,6N methanolic potassium methoxide. Equations are presented for the exchange of 5-H atom in 2- and 3-substituted thiophene derivatives and exchange of the 2-H atom in 3-substituted thiophenes. The equations are applicable to the 5-H exchange in thiazole and izothiazole. The inadequacy of the equations for the 2-H exchange in thiazole as well as the comparison of the exchange rates of aromatic and aliphatic CH-bonds in benzazoles indicate the α-lone pair effect of heteroatom –N= to be essential in five-membered cycles. A linear relationship is found between the logarithms of relative rate constants in DMSO and in methanol. It is concluded that the solvent differentiating action on an aromatic CH–bond kinetical acidity is absent in this series. (auth)

18964 PROPERTIES OF TRAPPED H AND D ATOMS PRODUCED BY THE PHOTOLYSIS OF HI IN 3MP-d_{14} GLASS. Long, Mervyn A.; Willard, John E. (Univ. of Wisconsin, Madison). J. Phys. Chem.; 74: 1207-13(19 Mar 1970).

Photolysis of HI dissolved in perdeuterated 3-methylpentane (3MP-d_{14}) glass at any temperature from 4 to 50°K produces trapped H atoms and trapped D atoms observable by ESR, as well as C_6D_{13} radicals formed by abstraction of D from the 3MP-d_{14} by hot H. C_6H_{13} radicals, but no trapped H atoms, are produced by photolysis of HI in 3 MP-h_{14} under identical conditions, indicating a major effect of isotopic substitution on the trapping capability of the matrix. The initial quantum yield of trapped H in 3MP-d_{14} (ca. 0.03) is independent of temperature over the range of at least 20 to 40°K but decreases with time of photolysis until a steady-state concentration is reached, while the concentration of C_6D_{13} and D continue to grow linearly. The fractional rate of decay of trapped H atoms following short illuminations decreases rapidly with time, but the decay curves for samples with different initial concentrations are superimposable after normalization for dose. The properties of trapped H produced in 3MP-d_{14} in Kel-F tubes are the same as when produced in quartz tubes. Trapped H atoms may be produced by photolysis of empty quartz tubes after certain conditions of aging and γ radiolysis. Trapped D (or H) atoms are not produced by the radiolysis of 3MP-d_{14} (or 3MP-h_{14}) with or without dissolved HI present, although photolysis of HI in radiolyzed 3 MP-d_{14} produces them. The implications of the data with respect to the mechanism of H atom trapping and decay are discussed. (auth)

18965 CHEMICAL AND INFRARED STUDY OF BASIC URANYL HALIDES. STUDY OF THEIR DIURANYL CONSTITUTION. Perrin, Andre (Univ., Rennes, France). Compt. Rend., Ser. C; 270: 319-22(19 Jan 1970). (In French).

The anhydrous or hydrated basic uranyl halides $UO_2(OH)X,0$ and $2H_2O(X = Cl$ or Br) constitute, in fact, the diuranyl halides because of their chemical properties and infrared spectra. They differ in their mode of dehydration. The anhydrous phase is written $[U_2O_5, H_2O]X_2$ as it results from the presence of the vibrator H_2O. The hydrated phase should be formulated as $[U_2O_5, H_2O]X_2 \cdot 4H_2O$ or $[UO_2(OH)_2UO_2]X_2 \cdot 4H_2O$. (France)

18966 MOESSBAUER SPECTROSCOPY OF ^{57}Fe PRODUCED BY THE ELECTRON CAPTURE OF ^{57}Co IN COBALTOUS HEXAAMMINE CHLORIDE. Friedt, J. M.; Cruset, A.; Asch, L.; Adloff, J. P. (CNRS, Strasbourg). Radiochem. Radioanal. Lett.; 3: 81-8(12 Mar 1970). (In French).

Moessbauer spectra of ^{57}Co-labeled $Co(NH_3)_6Cl_2$ sources were measured against a single line absorber. ^{57}Fe formed by electron capture of ^{57}Co is found as Fe^{3+} and as two Fe^{2+} species in different sites. The mechanism of the stabilization of the various states is based on autoradiolytic effects. (auth)

18967 ON THE STRUCTURE OF HYDROXYLAMINE URANIUM(IV) FLUORIDE. Ratho, T.; Patel, T.; Sahu, B. (Regional Engineering Coll., Rourkela, India). Indian J. Phys.; 43: 164-6(Mar 1969).

The structure of hydroxylamine uranium(IV) fluoride was studied by x-ray diffraction. The following cell dimensions for the orthorhombic crystal were obtained: a = 10.9630 ± 0.0660Å, b = 14.9024 ± 0.0890Å, and c = 10.4391 ± 0.0630Å. (J.G.B.)

18968 ACTIVITY OF THE HYDRATED METAL IONS IN HYDROLYSIS OF TERT-BUTYL FLUORIDE. Rudakov, E. S.; Kozhevnikov, I. V.; Zamashchikov, V. V. (Inst. of Catalysis, Novosibirsk, USSR). Reakts. Sposobnost Org. Soedin., Tartu. Gos. Univ.; 6: 573-9(Jun 1969). (In Russian).

The hydrolysis of t-BuF was found to be accelerated by aquated metal ions. The following metals form stable monofluoride complexes and were found to be catalytically active: Zr^{4+}, Th^{4+}, Sc^{3+}, Al^{3+}, Fe^{3+}, Ga^{3+}. K^+, Ag^+, Cu^{2+}, Zn^{2+}, Cd^{2+}, Hg^{2+}, and La^{3+} are inactive. H^+ showed a weak activity. A linear relationship was established between the value of log k of acid-catalysed hydrolysis of t-BuF and the Hammett acidity function. (auth)

18969 RELATION OF INTERIONIC DISTANCES IN CRYSTALLINE FRANCIUM HALIDES AND ALKALI METAL ASTATIDES TO TEMPERATURE. Krestov, G. A.; Krestova, N. V. Radiokhimiya; 11: 698-706(1969). (In Russian).

The temperature coefficients of the interionic distances and the linear coefficients of thermal expansion of crystalline francium halides and alkali metal astatides were calculated in the temperature range from 298.15°K to the melting point. Temperature orders of thermal capacity and changes in enthalpy were found. Changes in interionic distances in relation to temperature and the nature of the salt were studied. (tr-auth)

18970 BASE-CATALYZED DEUTERIUM EXCHANGE OF BICYCLO[2.2.1]HEPTANONES. Tidwell, Thomas T. (Univ. of South Carolina, Columbia). J. Amer. Chem. Soc.; 92: 1148-9 (11 Mar 1970).

Measurements of rates and stereochemistry of base-catalyzed deuterium exchange in representative bicyclo[2.2.1]-heptan-2-ones and application of these studies to the preparation of selectively deuterated compounds in this series are reported. The rates of deuterium uptake of the ketones in 2:1 dioxane–D_2O containing NaOD at 25°C were monitored by mass spectrometry; in all cases there was a relatively rapid uptake of a first deuterium, followed by the slower incorporation of a second deuterium. No trideuteration was observed. The stereochemistry of the first deuterium was found to be exo in all cases. The ketones examined were norcamphor, camphor, dehydronorcamphor, and benzodehydronorcamphor. The relative rates of deuterium uptake at various positions (all relative to the endo-3 position of norcamphor) are given, and the measured rate constants and exo:endo rate ratios are tabulated. (P.C.H.)

18971 VIBRATION SPECTRA OF THE ALKALINE EARTH URANATES. Caillet, P.; Brochu, R. (Rennes Univ., France). Bull. Soc. Chim. Fr.; 1: 41-6(Jan 1970). (In French).

The elementary crystalline lattice vibrations of alkaline earth uranates are determined by factor group analysis. These vibrations are classified as a function of the different atom groups that constitute the crystalline lattice. This classification explains the differences observed between the infrared and Raman spectra determined between 1,000 and 200 cm^{-1} for all these compounds. The calculated value of the U–O bond strength constant agrees with the predicted O=U=O group double bond character. (France)

18972 STABILITY CONSTANTS OF THE CHLORIDE AND NITRATE COMPLEXES OF NEPTUNIUM(V) AND NEPTUNIUM (VI). Al-Niaimi, N. S.; Wain, A. G.; McKay, H. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 32: 977-86(Mar 1970).

The stability constants of the chloride and nitrate complexes of neptunium(V) and neptunium(VI) were determined in $HClO_4$ at concentrations ranging from 0.3 to 0.8M. This was achieved by measuring the potentials of chemical cells containing equimolar proportions of neptunium(V) and neptunium(VI) along with varying concentrations of the complexing ligands. The valency of the neptunium was adjusted by controlled-potential coulometry. From the results a preferred mean value of the stability constant of NpO_2Cl^+ at 25 ± 0.01°C in 0.3 to 0.5M $H(ClO_4,Cl)$ of 0.46 ± 0.03 $mole^{-1}$ l was obtained. For $NpO_2NO_3^+$ there appeared to be some variation in the stability constant, from 0.105 ± 0.005 $mole^{-1}$ l in 0.4M $H(ClO_4,NO_3)$ to 0.130 ± 0.06 $mole^{-1}$ l in 0.6M $H(ClO_4,NO_3)$. There was some indication of the formation of small amounts of the second complexes NpO_2Cl_2 and $NpO_2(NO_3)_2$. (auth) (UK)

18973 POTENTIOMETRIC STUDY ON THE COMPOSITION AND STABILITY OF URANYL COMPLEXES OF 3,5-DINITROSALICYLIC ACID. Dube, S. S.; Dhindsa, S. S. (Government Coll., Rajasthan, India). J. Inorg. Nucl. Chem.; 32: 1041-2 (Mar 1970).

3,5-Dinitrosalicylic acid (H_2A) has been reported to form complexes with many metal ions, but no literature reference could be found to a potentiometric study of uranyl ion complexes of H_2A. In order to establish the stoichiometry of the complex species formed by interaction of UO_2^{2+} with H_2A, the magnitude of proton displacement was determined by titrating solutions containing the metal ion and ligand in different ratios against standard alkali. When a 1:1 mixture was titrated, three inflections were observed in the potentiometric titration curves. The first inflection corresponded to the formation of a 1:1 complex and the second to disproportionation of the 1:1 complex into 1:2 complex and uranyl hydroxide. The third inflection may have been due to decomposition of the 1:2 complex at higher pH into the disodium salt of the acid and uranyl hydroxide. When 3 moles of ligand were added to 1 mole of uranyl nitrate only two inflections were observed. The shift in end points was due to the presence of excess ligand. Stability constants were calculated from the potentiometric titration data; the mean values of log K_1 and log K_2 were found to be 7.0 and 5.5, respectively, at 35°C, where K_1 and K_2 are the formation constants of UO_2A and $UO_2A_2^{2-}$ complexes. (UK)

18974 PREPARATION OF ZrX_3 SINGLE CRYSTALS AND THE DIFFERENTIAL REDUCTION OF ZIRCONIUM FROM HAFNIUM IN MOLTEN Al_2X_6. Larsen, Edwin M.; Gil-Arnao, Francisco; Moyer, James W.; Camp, Michael J. (Univ. of Wisconsin, Madison). J. Chem. Soc., D; No. 5: 281-2(4 Mar 1970).

It was found that zirconium tetrahalides containing hafnium in natural abundance were reduced by metallic zirconium or aluminum in molten aluminum halides at 260 to 310° to yield soluble intermediates from which are deposited single crystals of ZrX_3 which have a reduced hafnium concentration. (auth) (UK)

18975 STABILITY CONSTANTS OF LANTHANIDE COMPLEXES WITH SALICYLHYDROXAMIC ACID. Seshadri, T. (Regional Research Lab., Assam, India). Talanta; 17: 168-70 (Feb 1970).

The stability constants of La, Pr, Nd, Sm, Eu, Gd, Dy, Er, Yb, and Y complexes of salicylhydroxamic acid were determined potentiometrically in 3:1 v/v acetone–water medium at 25 ± 0.5° and at an ionic strength of 0.1 with respect to sodium perchlorate. The stability constants were comparable with those of other lanthanide complexes with oxygen-donating ligands such as benzoylacetone and benzoylphenylhydroxylamine. (auth) (UK)

18976 KINETICS OF THE ADDITION OF SUBSTITUTED BENZENESULFINIC ACIDS TO p-BENZOQUINONE. Ogata, Y.; Sawaki, Y.; Isono, M. (Nagoya Univ., Japan). Tetrahedron; 26: 731-6(Jan 1970).

Addition of substituted benzenesulfinic acids to p-benzoquinone-h_4 and -d_4 was studied kinetically in aqueous solutions at pH below 6. The rate is expressed as v = k[quinone] × [sulfinate ion] and the second-order rate constant k satisfies the Hammett's equation, giving ρ values of −1.59, −1.55, and −1.64 at pH 1.90, 3.50, and 4.82, respectively. The significant isotope effect is observed at pH 4.82, k_H/k_D being ca. 1.5 to 1.8, but no kinetic isotope effect for the reaction at pH below 3.50. These results indicate that the rate-determining step shifts from the addition step to the deprotonation step with increasing pH, and that the substituents hardly influence the deprotonation step. The Hammett's ρ-value for the ionization of benzenesulfinic acids was ca. 1.07. (auth) (UK)

18977 THORIUM(IV)–8-QUINOLINOL COMPLEXES: REEXAMINATION OF THEIR COMPOSITION. White, Gordon M.; Ohnesorge, William E. (Lehigh Univ., Bethlehem, Pa.). Anal. Chem.; 42: 504-8(Apr 1970).

The orange Th(IV)-8-equinolinol material precipitated from slightly acidic aqueous solution is shown to be a nonstoichiometric mixture of tetrakis(8-quinolinolato)thorium(IV), ThQ_4, and 8-quinolinol, HQ, with the approximate composition $ThQ_4 \cdot 0.6HQ$; previously the 1:1 adduct, $ThQ_4 \cdot HQ$, was the accepted composition. The 4:1 chelate, ThQ_4, dissociates appreciably in absolute ethanol solution; its fourth step-wise formation constant, K_4, is ca. 10^{10}. (auth)

18978 DISSOCIATION CONSTANTS OF INORGANIC ACIDS AND BASES IN AQUEOUS SOLUTION. Perrin, D. D. (Australian National Univ., Canberra). Pure Appl. Chem.; 20: 132-236(1969).

The dissociation constants of inorganic acids and bases are given, in most cases, in the form of p_a^K values, and the classes of compounds include not only conventional acids and bases such as boric acid and magnesium hydroxide, but also hydrated metal ions (which behave as acids when they undergo hydrolysis) and free radicals, such as the hydroxyl radical, ·OH. All of these reactions have in common the gain or loss of a proton or a hydroxyl ion. On the other hand, the hydrolyses of metal-complex ions such as the cobaltammines have been excluded, as being more appropriate to the stability constant compilation mentioned. In the absence of experimental values, especially for some of the oxyacids, attempts have been made to predict p^K values, usually from similarities of structure. Because of the many different kinds of uncertainties inherent in the present p^K compilation, no attempt has been made to assess the accuracy of each entry. Nevertheless, where possible, attempts have been made to select what appear to be the best available values. (1046 references) (P.C.H.)

18979 COMPLETE ISOTOPIC FRACTIONATION OF PENTA-O-TRIMETHYL-SILYL-D-GLUCOSE AND PENTA-O-TRIMETHYL-d_{45}-SILYL-D-GLUCOSE BY GAS LIQUID CHROMATOGRAPHY MASS SPECTROMETRY. Waller, G. R.; Sastry, S. D.; Kinneberg, Keith (Oklahoma State Univ., Stillwater). J. Chromatog. Sci.; 7: 577-8(Sep 1969).

In the course of analyzing sugars by gas liquid chromatography–mass spectrometry, complete isotopic fractionation of penta-O-trimethyl-d_{45}-silyl-D-glucose (glucose-TMSi-d_{45}) and its protium form was observed. The complete separation by gas-liquid chromatography (GLC) of the deuterium and protium derivatives could have been predicted based on the results obtained earlier on the β-D-glucose-d_7TMS and β-D-glucose-TMS and on perdeuterated fatty acid methyl esters. However, the glucose derivative labeled with 45 deuterium atoms was not available earlier for experimental verification since BSA-d_{18} only recently became commercially obtainable. The use of bis-(trimethylsilyl) acetamide (BSA) and trimethylchlorosilane (TMCS) silylating reagents for sugars without using pyridine as a solvent is described. BSA-d_{18}-(>99 atom %) and TMCS-d_9-(>99 atom %) were used. The complete separation (by 4.67 min) of α-D-glucose-TMSi (mol wt 540) and α-D-glucose-TMSi-d_{45} (mol wt 585) is demonstrated. The anomeric forms had a longer retention time by 26 min. The deuterated derivative eluted from the column earlier than the protium form. The mass spectrum of the α-D-glucose-TMSi-d_{45} is shown. The separation factor for the protium–deuterium derivative pair is 1.141. (BBB)

18980 PMR STUDIES OF THE DEUTERATION AND HYDRATION OF 4-PIPERIDONES. Hassan, M. M. A.; Casy, A. F. (Univ. of Alberta, Edmonton). Org. Magn. Resonance; 1: 389-99(Oct 1969).

The PMR spectra of substituted 4-piperidones in base and salt forms in D_2O, water, and other solvents are reported, and spectral characteristics interpreted in terms of equilibria between free ketone and 4,4-dideuteroxy (or hydroxy) forms. Since D_2O was a more desirable solvent than water for much of this work, the D/H exchange of α-protons in 4-piperidones was also examined. Exchange of the α-protons of the 3-methyl-4-piperidone was followed by recording the change with time of the 3-methyl and ring PMR signals of a solution of the piperidone in D_2O. The 3-methyl signal, a clear doublet in $CDCl_3$ or water, showed a singlet midway between the doublet peaks in D_2O, which grew with time at the expense of the doublet. Spectral data on other 3-methyl-4-piperidone hydrochlorides confirmed their extensive reaction with D_2O. It was concluded that 1-mono and 1,3-disubstituted-4-piperidones exist extensively as the corresponding dideuteroxy (or hydrated) species in D_2O (or H_2O) provided the ring nitrogen atom is positively charged, and that 3-substituents decrease the population of these forms. The facile D/H exchange of α-protons in the piperidone bases was also demonstrated. (BBB)

18981 PROCESS FOR PREPARING α-AMMONIUM URANOUS PENTAFLUORIDE. (to Allied Chemical Corp.). British Patent 1,183,268. 4 Mar 1970. Filed 14 Nov 1967.

Crystalline, α-ammonium uranous pentafluoride was prepared by reacting HF, hydroxylamine or a hydroxylamine-yielding compound, and an aqueous solution of a uranyl salt containing chloride,

cupric, and ammonium ions at a temperature of at least 85°C. The concentration of hydroxylamine in the solution is maintained at at least 0.07 moles/l, and at least 75% of the U is converted to the ammonium uranium pentafluoride. (B.L.M.)

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Refer also to abstracts 19036, 19044, 19302, 19949, and 19965.

18982 (AD)698524) CHANGES IN INFRARED SPECTRA DURING IONIZATION AGING OF POLYMER FILMS. Koikov, S. N.; Kuksenko, V. S.; Paribok, V. A.; Yarmarkina, S. S. Translated from Tr. Leningrad. Politekh. Inst.; 276: 32-8(1966). 12p. (FTD-HT-23-16-69). CFSTI.

Polyethylene (I), polystyrene (II), and poly(ethylene terephthalate) (III) films were exposed to ionization discharges for 15 to 100 hours at room temperature in air or under oxygen. Ir spectra of treated and untreated samples were compared. The most apparent changes were observed in I, the spectra of III did not change, and the spectra of II showed small changes. The changes in spectra were accompanied by a decrease in resolution and an increase in background. The relative changes of I, II, and III films caused by ionization correspond to changes due to thermal oxidation and to irradiation in air. The changes in spectra agree well with the rate of oxygen absorption in the polymer films. The results show that I has a tendency toward oxidation and crosslinking, but is stable to ionization aging. III is very easily aged by ionization, but is not oxidized and crosslinked by ionization. The properties of II are intermediate between those of I and III. (USGRDR)

18983 (CEA-CONF-1413) RADIATION HARDENING COMPOSITIONS IN THE COLD FOR COATINGS OR OTHER APPLICATIONS. Blin, M. F.; Gaussens, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1969]. 25p. (In French). (CONF-690805-8). Dep. CFSTI (U. S. Sales Only).

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

Reticulation or reticulating grafting of mixtures of monomers and polymers by accelerated electrons was studied by working with solutions of very variable composition both with respect to the nature of the monomers and polymers and the monomer/polymer ratio. The reticulation reactions are the basis of phenomena that transform certain varnishes, paints, and coatings to hard insoluble products having an improved chemical stability. The coatings are applied on a support and reticulated on them by irradiation with an intense beam of accelerated electrons. Three types of polymers were studied: linear polyesters, modified epoxydic polymers, and polyacrylics. It was thus possible to show the effect of different parameters—dose between 1 and 2 Mrad, dose output between 0.008 and 1.7 Mrad/sec, reactivity of the monomer/polymer mixture, and oxygen of the air—on the rate of formation of the gel. The irradiation reticulation process avoids the use of additives (organic peroxides and catalysts) and/or heat; it suppresses the numerous problems that occur during the application of varnishes and paints (elimination or recovery of solvents having the dangers of fire and intoxication, storage of objects during drying, limited chemical and physical stability of varnishes and paints, etc.). In addition to its rapidity of action, the procedure using the action of radiation for the hardening of coatings can be applied to articles of every nature and avoids their alteration in the case of woods, cement coatings, concretes, plaster coatings, plastic coatings, paper, and leather. The treatment is done at room temperature. (tr-auth)

18984 (CONF-691036) CONFERENCE ON THE USE OF IONIZING RADIATION IN INDUSTRIAL PROCESSES, PARIS, OCTOBER 20-21, 1969. (Association Technique p. r l'Energie Nucleaire, Paris (France)). 70p. (In French).

Information on the use of ionizing radiation in industrial processes, such as radiovulcanization of rubber, radioinduced polymerization of monomers and plastics, and radioreticulation of elastomers is presented in discussion form. (P.C.H.)

18985 (COO-1617-19) HALOGEN ATOM REACTIONS ACTIVATED BY RADIATIVE NEUTRON CAPTURE AND ^{82m}Br AND ^{130m}I ISOMERIC TRANSITION. Progress Report No. 4, February 1969-February 1970. (Nebraska Univ., Lincoln. Dept. of Chemistry). 15 Feb 1970. Contract AT(11-1)-1617. 96p. Dep. CFSTI.

Developments in research are reported for the following studies: radiometric analysis of serum and tissue proteins; radiative neutron capture and isomeric transition activated reactions of halogens and interhalogens in liquid (25°) and solid (77°K) benzene; application of isotopically labeled bromine for the determination of trace unsaturation in alkanes; a study of the various nuclear processes of iodine ($^{127}I_2$ and $^{129}I_2$) and iodine monochloride in selected alkylbenzenes and cyclopentane; gas phase reactions of ^{128}I, ^{130}I + ^{130m}I, ^{38}Cl activated by radiative neutron capture, and ^{130}I activated by isomeric transition in CH_4, CD_4, and polyhalomethanes; and, Szilard-Chalmers organic yields in liquid and solid alkyl iodides. (J.G.B.)

18986 (NP-18126) CHEMICAL BEHAVIOR OF ^{14}C AND ^{13}N HOT ATOMS IN NITRIDES AND CYANIDES. Kuhry, Jean-Georges (Strasbourg Univ. (France). Faculte des Sciences). 1970. 101p. (In French). Dep. CFSTI (U. S. Sales Only). Thesis.

The targets were irradiated either by thermal neutron fluxes in CEA reactors (for ^{14}C), or by 14-MeV neutrons (for ^{13}N). After the targets were dissolved, the labeled compounds were separated in presence of carriers. Gases were analyzed by gas radiochromatography. The chemical behavior of the recoil atoms ^{14}C and ^{13}N in the nitrides was studied first. The total activity in ^{14}C is distributed over four chemical forms: carbide, cyanide, cyanamide, and isocyanate. The carbide and the cyanide are found to be the only two compounds produced in a primary stage. The field ratio of the two species varies as a function of the atomic radii, r_{Me} and r_N. The proportion of the carbide ^{14}C increases with the relative probability of collision with nitrogen. No significant effect could be found for the atomic masses, in opposition with atomic radii effects. The collisions are found to be inelastic. The bonds in Ca_3N_2 and Ba_3N_2 are becoming ionic and the yield in carbide ^{14}C decreases. A special behavior is equally observed for the zirconium and hafnium nitrides. The total ^{14}C activity appears in the carbide form. Inefficiency of collisions with the metal is due to the focused propagation of the energy along crystal lines, without atomic shift. The propagation of the energy along crystal lines, without atomic shift. The crystallographic nature of ZrN and HfN favors this mode of energy transfer. Entire ^{13}N activity appears in ^{13}NMe and ^{13}NN. The nitride formation (retention) is mainly favored by the rather low recoil energy of the ^{13}N atoms (~10^3 eV). The nuclear reaction (n,2n) mechanism is a direct interaction between the incident neutron and a neutron of the target nucleus. Then, different chemical forms of ^{13}N and ^{14}C in sodium and potassium cyanides are studied. An important radiolytic decomposition of the targets through the irradiation is noticed. The elementary ^{14}C is associated to amorphous carbon issued from the cyanide radiolysis. The chemical mechanisms occur only at the end of the hot atom range (E > 20 eV), which reacts with the fragments produced through the last collision. Moreover, ^{13}N can react very easily with a CN^- ion to form a cyanamide. On the contrary, ^{14}C has no action onto CN^- ion. The reactor radiation effects are attributed to the decomposition of an intermediary complex $(CN)_2^-$ produced through the interaction between a radical CN and a CN^- ion. The ^{14}C labeled cyanamide results from an equivalent mechanism. A considerable influence of temperature was observed on irradiations in reactors. (France)

18987 (NP-18168) INVESTIGATIONS ON THE SEPARATION OF (α,xn) PRODUCTS FORMED BY COMPOUND NUCLEI OR DIRECT REACTIONS WITH THE HELP OF RANGE DISTRIBUTIONS IN HYDROGEN. Trissl, H.-W.; Muenzel, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Dec 1969. 12p. (In German). Dep. CFSTI (U. S. Sales Only).

The investigation of ^{197}Tl ions, formed by the ^{197}Au(α,4n) reaction, shows that more than 66% of the recoils emerging from the target and stopped in hydrogen gas can be collected on a negatively charged electrode. The positively charged ions may be transported in an electric field for at least 20 cm with only a slight loss of intensity. The half widths of the range distribution curve for the ^{197}Tl recoils are so large that it is not possible to determine the relative importance of the different reaction mechanisms. (auth)

18988 RADIATION-INDUCED CIS-TRANS ISOMERIZATION OF SOLUTIONS OF 2-PENTENE IN CYCLOHEXANE. van Ingen, J. W. F.; Cramer, W. A. (Interuniversitair Reactor Instituut, Delft, Netherlands). J. Phys. Chem.; 74: 1134-9(5 Mar 1970).

The cis-trans isomerization of solutions of 2-pentene in cyclohexane has been studied at room temperature as a function of pentene concentration. Effects of various additives, notably CH_3OH, NH_3, piperidine, O_2, I_2, CCl_4, C_3H_5Br, N_2O, C_7F_{14}, and SF_6 were investigated. In the presence of I_2, C_2H_5Br, and SF_6 a chain reaction occurred, as was evident from the very high isomerization yields. A chain reaction was also observed in the 2537-Å photolysis of solutions containing C_2H_5Br and 2-pentene. It is suggested that Br and I atoms and SF_5 radicals act as chain carriers. In the absence of a chain reaction, isomerization proceeded via excited 2-pentene molecules, formed by charge transfer from $C_6H_6^+I_2^-$ to the olefin and subsequent neutralization with electrons or negative ions. (auth)

18989 IRRADIATION OF DIHYDROTHYMINE IN FROZEN SULFURIC ACID SOLUTIONS. Henriksen, Thormod; Snipes,

Wallace (Univ. of California, Berkeley). Contract W-7405-eng-48. Radiat. Res.; 41: 439-49(Mar 1970).

Frozen solutions of dihydrothymine in H_2SO_4, electron irradiated at 77°K, contained large amounts of thymine after melting. Concentration studies showed that the thymine must be produced mainly by indirect mechanisms. Low-temperature uv absorption measurements revealed that thymine is not present after irradiation at 77°K, but is formed upon warming of the samples to about 160° to 200°K. ESR experiments suggest that the 5-thymyl radical is an intermediate in the production of thymine. At 77°K the irradiated samples contained only H atoms and some other unidentified H_2SO_4 radicals. The 5-thymyl radicals were formed upon warming to temperatures above 105°K, and they disappeared in the temperature range at which thymine was formed. (auth)

18990 LUMINESCENCE OF LIQUID ALKYL BENZENES UNDER HIGH-INTENSITY IONIZING IRRADIATION. Birks, J. B. (Univ. of Manchester, Eng.). Chem. Phys. Lett.; 4: 603-6 (1 Feb 1970).

Studies showed that the enhanced excimer ($^1M_2^*$) fluorescence from a liquid alkyl benzene under high-intensity ionizing irradiation originates from dimer cation ($^2M_2^+$) neutralization, associated with ionization quenching of excited molecules and depletion of unexcited molecules. Other emission bands may be due to triplet excimers ($^3M_2^*$) and excited singlet excimers ($^1M_2^{**}$), the latter corresponding to the $^1B_{2g}$ benzene excimer state. (auth)

18991 F-AGGREGATE AND IONIZED F-AGGREGATE CENTERS IN SODIUM FLUORIDE. Konrad, Karl. Chicago; Illinois Inst. of Tech. (1969). 162p.

Thesis.

The properties of F-aggregate and ionized F-aggregate centers in NaF were examined in samples x-irradiated at liquid nitrogen temperature and then warmed, samples x-irradiated at room temperature, and in x-irradiated samples after optical bleaching. These studies have resulted in the identification of the M^+ band at 737 nm, a higher excited R^+ center state at 302.5 nm (presumably R_2^+), and higher excited states of the M center, M_1: 498.6 nm, M_2: 340.0 nm, M_2': 337.5 nm. X irradiation at liquid nitrogen temperature forms a very intense F' band (λ_{max} = 470 nm, $H_{80°K} \approx 0.8$ eV) which decreases as a result of warming. A band at ca. 725 nm begins to appear at ca. 260°K. Formation of M centers accompanies the appearance of the 725-nm band which is assigned to M^+ centers resulting from capture of α centers by F centers. The intensity changes resulting from low temperature x irradiation give the ratios $\Delta A_{R_2}/\Delta A_{R}+ \approx 1$ and $f_{R_2}/f_{R}+ \approx 1$. In optical bleaching experiments relatively large concentrations of R^+ centers can be formed and a new band at 302.5 nm was observed. Bleaching NaF, x irradiated at liquid N_2 temperature and then annealed, or x irradiated at 30 ± 5°C, with 365 nm light produces large M_1 and R^+ bands. M_1-band growth is rapid (it saturates in ca. 10 to 15 min) and proceeds until its intensity exceeds that of the F band. Oriented distributions of M centers were then produced by further optical irradiation with plane polarized light. (TSS) (Diss. Abstr.)

18992 VALENCE DISTRIBUTION OF RADIOPHOSPHORUS IN POTASSIUM CHLORIDE SINGLE CRYSTALS. PART 3. EFFECT OF IONIZING RADIATION. Baptista, J. L.; Newton, G. W. A.; Robinson, V. J. (Univ. of Manchester, Eng.). Trans. Faraday. Soc.; 66: 213-19(Jan 1970).

The effect of gamma radiation on the valence distribution of radiophosphorus in KCl single crystals was studied. The radiophosphorus was produced by the nuclear reaction $^{35}Cl(n,a)^{32}P$, using either reactor spectrum neutrons of 14-MeV neutrons from a D-T source. Post-gamma irradiation at 77°K produced no change in the amount of phosphate [P(V)], but at 298°K small doses (about 0.1 Mr) caused rapid oxidation. These results were interpreted in terms of reactions between ^{32}P and transient hole species (radiolysis products). The ^{32}P valence distribution is less sensitive to pre-gamma irradiation of the crystals. At 77°K the P(V) fraction only increased by a small amount, whereas at 298°K, the marked decrease in P(V) required relatively large doses (about 60 Mr). This decrease was ascribed to pre-gamma irradiation inhibiting an efficient in-pile oxidation reaction. In addition, results of experiments in which the length of the reactor irradiation was varied were interpreted in terms of reactions of energetic ^{32}P recoil species. (auth) (UK)

18993 KINETIC INVESTIGATION OF THE RADIATION-INDUCED ISOTOPIC EXCHANGE BETWEEN IODOBENZENE AND IODINE IN BENZENE. Riess, R.; Elias, H. (Technische Hochschule, Darmstadt, Ger.). J. Phys. Chem.; 74: 1014-21 (5 Mar 1970).

The isotopic exchange between iodobenzene and radioactive elementary iodine induced by ionizing radiation (^{60}Co) has been investigated in benzene as a solvent. The kinetic measurements have been made at 30° in the absence and the presence of oxygen and at different dose rates. The following rate law has been derived both for aerated and oxygen-free solutions: $R = (\alpha[I_2]^{\frac{1}{2}})/(1 + \beta[I_2]/[PhI])$. No dose rate effect has been observed. The mechanism is discussed. (auth)

18994 ELECTRON PARAMAGNETIC RESONANCE STUDIES OF SILVER ATOM FORMATION AND ENHANCEMENT BY FLUORIDE IONS IN γ-IRRADIATED FROZEN SILVER NITRATE SOLUTIONS. Bales, Barney L.; Kevan, Larry (Univ. of Kansas, Lawrence). J. Phys. Chem.; 74: 1098-1103(5 Mar 1970). (COO-1528-35).

The γ radiolysis of $AgNO_3$ ices at 77°K produced trapped Ag^0, OH, and NO_2. Addition of fluoride ion increased Ag^0, prevented NO_2 formation, increased the total number of observable spins, and increased the linear range of the dose–yield curve for Ag^0. The initial Ag^0 yields were $G(ag^0) = 1.2$ in 1 M $AgNO_3$ and $G(Ag^0) = 3.2$ in 1 M $AgNO_3$–0.5 M KF. These effects indicated that fluoride ion acts as an efficient hole trap for H_2O^+ and prevents electron–hole recombination. Low fluoride concentrations were effective; thus some H_2O^+ is mobile. (auth)

18995 LOW-TEMPERATURE RADIOLYSIS OF AQUEOUS ALKALINE SOLUTIONS. Pristupa, A. I.; Prikhid'ko, I. N.; Sharpatyi, V. A. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim.; No. 2, 488-91(Feb 1970). (In Russian).

The radiochemical properties of vitreous KOH solutions (10 M) were studied at 77°K over a wide range of doses. The EPR method was used to determine the effects of ^{60}Co γ rays on the accumulation and yield of $e^-_{stabilized}$, O^-, and H in KOH solutions at 8.3×10^3 to 2.2×10^7 rad doses. Step: line curves were developed for O^- and H accumulation as a function of absorbed doses. (R.V.J.)

18996 DISCOVERY OF A σ RADICAL IN X-IRRADIATED MALONIC ACID. McCalley, Roderick C.; Kwiram, Alvin L. (Harvard Univ., Cambridge, Mass.). J. Amer. Chem. Soc.; 92: 1441-2(11 Mar 1970).

The discovery by ESR of a new σ-radical species in x-irradiated malonic acid is reported. The ^{13}C and proton hyperfine tensors were determined as well as the g tensor for the oriented radical trapped in the malonic acid crystal, and it is shown that it can be characterized as a monosubstituted acetyl radical, $RCH_2C{=}O$ (R = -COOH). (P.C.H.)

18997 ELUTION PARAMETERS OF THE ^{99}Mo–^{99m}Tc GENERATOR. Tippetts, Roger D.; Kenney, Gordon N. (Veterans Administration Hospital, Denver. Presbyterian Hospital, Denver). J. Nucl. Med.; 10: 550-2(Aug 1969).

An analysis of elution curves revealed the following important points: There are significant differences between the generators available on the market. Some curves reveal the position for the maximum possible instantaneous activity that can be obtained for any given generator as a function of volume eluted. Some curves give information as to the efficiency of any given elution. In any given elution into a single vial, the point of maximum obtainable concentration is revealed. It is recommended that each user of a radioisotope generator determine the curves for the particular elution method used. It is necessary to consider the parameters of specific activity, total volume, total activity, and positions of the maximum activity and specific activity in the elution scheme and the elution method. (auth)

18998 HOT-ATOM CHEMISTRY OF POLYPHOSPHATES. III. REACTIONS OF ^{32}P RESULTING FROM NEUTRON ACTIVATION OF HIGHER POLYMER. Matsuura, Niro; Lin, Tsing-ko (Tokyo Univ.). J. Inorg. Nucl. Chem.; 32: 353-60(Feb 1970).

For study of the reactions of ^{32}P in polymer phosphate during neutron activation polyphosphates with mean chain lengths, $\bar{n}$, of 10 and ∞ (Graham's salt) were used as target materials. The yield of recoil ^{32}P monomer was found to be much lower than that for tripolyphosphate, but three oxidation states of radiophosphorus, (+1), (+3) and (+5), were found in the recoil species. The distribution of the three states could be varied by changing the irradiation conditions and target materials. The specific activity decreased with increase of polymer chain length. Bond breakage of polyphosphate during alkaline hydrolysis occurred in units of four $(PO_3)^-$, and the accumulation of tetramer and the further hydrolysis of this species led to the conclusion that radioactive labelling occurred only at the end atom of the long phosphorus chain. (auth) (UK)

18999 GRAFT CO-POLYMERIZATION OF HYDROPHILIC MONOMERS ONTO POLYESTER FIBER. Sakurada, Ichiro; Okada, Norio (Japan Atomic Energy Research Inst., Osaka). Nihon Kagaku Seni Kenkyusho Koenshu; No. 26, 13-30(Oct 1969). (In Japanese).

Graft copolymerization of 4-vinylpyridine, acrylic acid, etc., on polyethylene terephthalate (PET) fibers was carried out by irradiation and by use of CCl_4 as an initiator. In the grafting of

4-vinylpyridine in aqueous solution on amorphous PET fiber, addition of acrylic acid inhibited formation of nongrafted polymers and was effective in eliminating fiber agglutination. In the graft copolymerization of acrylic acid in solution on PET fiber, addition of pyridine gives a porous fiber and increases the grafting ratio. Impregnation of the PET fiber with CCl_4 accelerates the radio-induced grafting. By elongation and heat treatment after graft copolymerization, fiber is obtained with mechanical and heat stability similar to the original fiber. Reaction of the 4-vinylpyridine with ethyl bromide to yield a quaternary derivative after grafting or conversion of some of the acrylic acid to the Na salt markedly increased the hygroscopicity of the grafted fiber. (NSA of Japan)

19000 CHEMICAL EFFECTS CAUSED BY THE NUCLEAR TRANSFORMATION SUCH AS IT, β^+, AND EC DISINTEGRATION. Omori, Takashi; Sasaki, Teikichi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 128-31(Jun 1969). (In Japanese).

The chemical behavior of ^{57}Co, generated from β^+ (EC) disintegration of ^{57}Ni, was studied. The initial yields and the annealing effects of ^{57}Co chemical species in hexammine-nickel(II) complexes were investigated by ion exchange. The initial yields were higher with the stronger oxidation species. For annealing at 60°C, the yields of $^{57}Co(III)$ chemical species depended on the oxidation strength of the anion, but at 80°C no such tendency was noted. The EDTA complex was synthesized using ^{57}Ni prepared with the LINAC, and the distributions of ^{57}Co generated were investigated by ion exchange. The yields of $^{57}Co(III)-EDTA$ complex were not dependent on the pH of the solution, the period between the preparation and analysis, or the temperature. Using ^{80m}Br generated from $^{81}Br(\gamma,n)^{80m}Br$ reaction, the annealing curves of $K^{80m}BrO_3$ were obtained and by applying Bateman's equation, the rate constant of annealing was found to be changed with a variation of time. The ratio of annealing in ^{80m}Br salts of alkaline earth metals depended on the kinds of cations and indicates that in the annealing of recoil atoms the electrostatic factor plays an important role. (NSA of Japan)

19001 STUDY BY EPR OF THE RADIOLYSIS OF CYCLOTRIMETHYLENETRINITRAMINE. Darnez, Charles; Paviot, Jacques; Cherville, Jean. J. Chim. Phys.; 66: 2016-7(Nov-Dec 1969). (In French).

EPR spectral studies were made on γ-irradiated polycrystalline and benzene solutions of hexahydro-1,3,5-trinitro-s-triazine (cyclotrimethylenetrinitramine). The results on polycrystalline samples showed that the spectra were the same after γ or uv irradiation. A monomolecular absorption process was observed in the solid phase, with the existence of NO_2^+ in the primary products, the trapping of NO_2^+ in the matrix, and the progressive destruction of traps as a function of time and temperature. (P.C.H.)

19002 CHEMICAL EFFECTS ACCOMPANYING RADIATIVE DISINTEGRATION. Omori, Takashi; Sasaki, Teikichi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 1, 74-6(1968). (In Japanese).

The chemical effects caused by β disintegration, isomeric transition, and (γ,n) reaction were studied and preliminary results are presented. Uranyl oxalate, either anhydrous or hydrous, was irradiated with 60-MeV radiation, and oxygen was found to play an important part in thermal annealing of the compound. Retention was inversely dependent on the number of waters of crystallization. Labeled $KBrO_3$ and $NaBrO_3$ were synthesized with ^{80m}Br, and the retention of the ^{80m}Br was measured after storage at liquid air temperatures, room temperature, and 100°C. The distribution of ^{57}Co produced from ^{57}Ni in $^{57}Ni(NH_3)_6ClO_4$ and $^{57}Ni(en)_3ClO_4$ was observed. Annealing occurred even at room temperature, especially in the case of the ethylenediamine complex. (NSA of Japan)

19003 RADIOSENSITIVITY OF HEMIN UNDER NEUTRON BOMBARDMENT. Vereecken, Alfred; Apers, Desire; Capron, Paul (Univ., Louvain, Belgium). J. Chim. Phys.; 66: 1837-9 (Nov-Dec 1969). (In French).

The chemical effects of radiative neutron capture of iron in hemin and in the hemin-pyridine complex have been investigated. A method allowing the separation and determination of the two recoiling isotopes ^{59}Fe and ^{59}Fe, is described. The retention values and the associated isotope effect can be correlated to the recoil energies of the nuclei. Thermal annealing has little effect on the retention. (auth)

19004 STUDIES ON THE PREPARATION OF SPECIAL RADIOISOTOPE ^{47}Ca, ETC. Shiokawa, Takanobu; Omori, Takashi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 1, 68-71(1968). (In Japanese).

The production of ^{47}Ca by bremsstrahlung irradiation was studied. The targets used were natural calcium carbonate, and ^{46}Ca-enriched calcium carbonate. They were irradiated with the bremmstrahlung of 20 and 60 MeV from electron accelerators, for 3 and 2 to 4 hours, respectively; platinum was used as the converters. The irradiated samples were purified either by precipitation or by ion exchange. ^{47}Ca was produced as follows, in terms of the neutron yield: for the natural calcium target, 9.6×10^4 n/R/mole, and for the enriched target, 4.1×10^6 n/R/mole. For the enriched target, the contamination by ^{45}Ca was relatively high, therefore consideration must be given to the concentration of ^{46}Ca in this case. (NSA of Japan)

19005 GRAFT CO-POLYMERIZATION OF ACRYLONITRILE ONTO POLY(VINYL) CHLORIDE FIBER. Sakurada, Ichiro (Japan Atomic Energy Research Inst., Osaka); Hosono, Masao. Nihon Kagaku Seni Kenkyusho Koenshu; No. 26, 1-12(Oct 1969). (In Japanese).

Graft copolymerization of acrylonitrile on unelongated poly (vinyl chloride) fiber was carried out by irradiation and by catalysis. In both cases, by elongation and heat treatment after the grafting, a grafted fiber with high elongation-strength and good heat resistance was obtained. However, irradiation techniques gave somewhat better results than catalysis. Irradiation gave a grafting yield of 90 to 100%, about 100% better than that obtained with a catalyst. Also, irradiation produced a transparent, colorless product while the product from a catalyzed grafting was white and opaque. (NSA of Japan)

19006 ION NEUTRALIZATION REACTIONS IN IRRADIATED HYDROGEN CHLORIDE, HYDROGEN BROMIDE, AND NITROUS OXIDE. Wilson, D. E.; Armstrong, D. A. (Univ. of Calgary, Alberta). Can. J. Chem.; 48: 598-602(15 Feb 1970).

Rates of ion neutralization were measured in hydrogen chloride, hydrogen bromide, and nitrous oxide by collecting the ions remaining in a defined volume at various times after ionization by a pulse of 120 k.v.p. x rays. Values of the total homogeneous ion–ion recombination coefficient, α, were obtained for each gas over a range of pressures in the region 50 to 650 torr. From a study of the effects of pressure and ion density, the relative rates of wall diffusion, mutual neutralization, and three-body neutralization were deduced. (auth) (Canada)

19007 CHEMICAL EFFECTS DURING NUCLEAR TRANSMUTATION SUCH AS ISOMERIC TRANSITION AND β^+ AND ELECTRON CAPTURE DECAYS. Omori, Takashi; Sasaki, Teikichi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 129-32(Dec 1968). (In Japanese).

After the irradiation of potassium chromate by 30- to 65-MeV bremsstrahlung for 20 to 30 hr, the chemical behavior of ^{51}Cr produced by the $^{52}Cr(\gamma,n)^{51}Cr$ reaction was investigated. Initial retention of ^{51}Cr increased with increasing γ irradiation intensity, and the retention also increased with an increase in temperature when isothermal annealing was carried out. After the irradiation of nickel oxide by 60-MeV bremsstrahlung for 2 hr, ^{57}Ni, which was produced by the $^{58}Ni(\gamma,n)^{57}Ni$ reaction, was separated from ^{57}Co, and ^{57}Ni labeled hexamminonickel(II) complex was prepared. After keeping it at the dry ice temperature, the distribution of ^{57}Co-labeled chemical species was examined. Five kinds of ^{80m}Br-labeled bromates of alkaline metals were prepared by $^{81}Br(\gamma,n)^{80m}Br$ reaction, and the chemical effects during isomeric transition in solid phase were investigated. The yield of $^{80g}BrO_3^-$ depended on the temperature at which the crystal was stored and increased remarkably at high temperature. Furthermore, chemical effects of ^{80m}Br in the ethyl bromide–bromine system during isomeric transition are reported. (NSA of Japan)

19008 ACTION OF GAMMA RADIATION ON ALUMINOCALCIUM GLASSES ACTIVATED BY RARE EARTH AND TRANSITION METALS. Galimov, D. G.; Lun'kin, S. P.; Yudin, D. M. Zh. Prikl. Spektrosk.; 11: 1127-30(Dec 1969). (In Russian).

An investigation was made on gamma-irradiated glasses with a composition 10% SiO_2–30% Al_2O_3–60% CaO, activated by rare earth ions and by divalent manganese. On irradiation of glasses without additives, EPR signals developed. Relation of the amplitude of the signals to the concentration of added Mn^{2+} ions established their hole origin. It was concluded that holes are captured on node points (AlO_4) and (AlO_6). From the change in relative amplitude of induced EPR signal, conclusions were drawn concerning the efficiency of reduction or oxidation of rare earth ions. (tr-auth)

19009 γ-INDUCED ADDITION OF TRICHLOROSILANE TO VINYL ACETATE. Tsurugi, Jitsuo; Nakao, Ren; Fukumoto, Tsugio (Radiation Center of Osaka). J. Org. Chem.; 35: 833-5 (Mar 1970).

A study of the γ-induced addition of trichlorosilane to vinyl acetate, conversion of the trichlorosilyl group of the 1:1 adduct

to the ethoxysilyl group, and the subsequent pyrolytic loss of acetic acid from the 1:1 adduct and its triethoxylated compound is reported. Distillation of the irradiated mixture of trichlorosilane and vinyl acetate yielded three fractions, 2-trichlorosilylethyl ethyl ether; the 1:1 adduct, 2-trichlorosilylethyl acetate; and the 1:2 adduct, 4-trichlorosilyl-3-acetoxybutyl acetate. (D.H.M.)

19010 RECOMBINATION OF HYDROGEN AND OXYGEN IN THE PRESENCE OF INERT GASES UNDER THE INFLUENCE OF GAMMA RADIATION. Milner, Sofia. Minneapolis; Univ. of Minnesota (1969). 137p.

Thesis.

The γ-induced recombination of hydrogen and oxygen to produce water in the presence of inert gases was studied. The experimental equipment used included a vacuum system (vacuum of 10^{-6} mm Hg or better), ^{137}Cs irradiation source, pyrex reactor of about 100 ml in volume, and gas chromatography for the analysis of the residual gases (concentrations less than 1 μmole). Ethylene was used as the gas dosimeter. The ranges of the variables studied were as follows: initial hydrogen concentration, 0.046 to 0.27 mm Hg; initial oxygen concentration, 0.018 to 0.18 mm Hg; time of irradiation, 0 to 30 hr; initial inert gas concentration, 0 to 0.07 mm Hg; exposure dose rate, 0 to 0.3 Mr/hr, i.e., 0 to 10 pencils; and temperature, 30 to 200°C. The inert gases used were helium, neon, argon, krypton, and xenon. A kinetic mechanism was proposed and experimental data that corroborates the mechanism was obtained. The mechanism is a chain reaction mechanism inasmuch as the G values obtained were of the order of 10^2 to 10^3 molecules/100 eV. The model proposed utilizes excited molecules as the initiation and considers the propagation and termination steps by free radicals. The reaction was found first order in hydrogen concentration, in oxygen concentration, and in dose rate. The dependence of the rate on the inert gas present and on its concentration is of the form $\{[(R) + c]\}/\{[(R) + a][(R) + b]\}$ where a, b, and c are constants with values depending on the R (inert gas). The relationships of the constants with rate constants in the proposed mechanism were explored, including comparisons with related values obtained from the literature. The rate is independent of temperature up to 125°C. An increase in the rate was found for temperatures above 125°C. (Diss. Abstr.)

19011 ELECTRON SPIN RESONANCE STUDIES OF SELECTED GAMMA-IRRADIATED ORGANIC COMPOUNDS AND ELECTRON-IRRADIATED SINGLE CRYSTALS OF ZINC OXIDE. Smith, James Marshall. Morgantown, W. Va.; West Virginia Univ. (1969). 149p.

Thesis.

The results of ESR studies on the interaction of γ radiation with some selected organic compounds and of fast electrons with single crystals of ZnO (both pure and Li-doped), are presented. An analysis of isotropic and anisotropic hyperfine splitting of Zeeman levels is presented to aid in the interpretation of ESR spectra of irradiated organic radicals. A discussion of the types of organic bonding that allow hydrogen atom attachment is presented. The results are inconclusive except in the case of γ irradiated dehydroacetic acid, which appears to form a free radical different from the expected hydrogen atom attachment. The interaction of radiation with inorganic solids is discussed by introducing the concept of point defects. In particular F centers in the alkali halides and the alkaline earth oxides are mentioned. ESR spectra of electron bombarded (~1.7 MeV) ZnO single crystals are discussed. ESR and optical absorption measurements were performed on electron irradiated pure and Li-doped single crystals during isochronal annealing of the induced color centers. Crystals irradiated with different electron doses were also compared by ESR and optical absorption measurements. The high field line could be correlated with the induced optical absorption. No induced coloration nor ESR lines were found in crystals irradiated with 0.6-MeV electrons. Results of low-temperature studies and measurements on additively colored ZnO crystals are discussed. Comparison of these results with F centers in alkaline earth oxides suggests that the color center in the electron-bombarded ZnO single crystal is an F center. Observed hyperfine structure of the optically enhanced high field line is in agreement with the model of a trapped electron coupled to two nonequivalent ^{67}Zn isotopes, which one would expect for an F center in ZnO. Therefore the assignment of an F center being responsible for the color center in an electron-irradiated ZnO single crystal is not inconsistent with the data. There is no evidence that the same center is responsible for coloration in an additively-colored ZnO single crystal. (Diss. Abstr.)

19012 CHEMICAL ANNEALING REACTIONS IN METAL CARBONYLS. Zielinski, Florian Witold. Buffalo; State Univ. of New York (1969). 131p.

Thesis.

The kinetics of the reconstruction of the target molecule from the fragments generated by thermal neutron activation of chromium hexacarbonyl and molybdenum hexacarbonyl was determined as a function of (1) dose absorbed during activation, (2) post-irradiation thermal treatment (26° to 150°C), (3) pre- and post-electron irradiation, and (4) post-irradiation exposure to atmospheres of carbon monoxide and nitrogen. Pure crystals of the hexacarbonyl were irradiated at 0°C at the face of the core of a 2-MW PULSTAR research reactor. The annealing isotherms showed that the rate and extent of reconstruction increase monotonically with increasing temperature from the initial retention value [50.2 ± 0.8% for $Cr(CO)_6$ and 66.1 ± 1.2% for $Mo(CO)_6$] to a pseudo-plateau in less than one hour. The extent of reconstruction as indicated by the pseudo-plateau value reached 71% in $Cr(CO)_6$ and 82% in $Mo(CO)_6$. $Cr(CO)_6$ crystals subjected to 1200 psig carbon monoxide pressure during isothermal annealing did not show an enhancement of reconstruction under the conditions of this investigation. $Mo(CO)_6$ did exhibit an enhancement due to this external atmosphere of carbon monoxide. A similar pressure of nitrogen did not cause enhancement. The rate and extent of subsequent annealing in $Mo(CO)_6$ was enhanced by increasing the γ dose delivered during neutron activation from 0.21 MR to 0.35 MR. Preactivation bombardment with 1.5-MeV electrons (50 MR) from a Van de Graaff accelerator inhibited thermal annealing at 25°C of (n,γ) activated $Cr(CO)_6$. Enhancement of annealing resulted from 1.5-MeV electron bombardment coupled with thermal treatment subsequent to (n,γ) activation of $Cr(CO)_6$. A 30-MR dose increased retention from 56% to 70% at 25°C. A mechanism consistent with the data assumes that the neutron activation produces a carbon monoxide deficient, ^{99}Mo or ^{51}Cr containing, fragment and free carbon monoxide groups, which are localized nearby. During an annealing treatment these latter groups either diffuse to the recoil site and participate in the reconstruction or they may diffuse away. Reconstruction may be influenced also by long range diffusion of radiolytic carbon monoxide as well as carbon monoxide from the external atmosphere. (Diss. Abstr.)

19013 ^{13}N AND ^{15}O RECOIL REACTIONS IN GASES. Statnick, Robert Michael. Lafayette, Ind.; Purdue Univ. (1969). 124p.

Thesis.

Recoil reactions of ^{15}O in N_2, N_2O, NO, CO, and CO_2 were studied. From scavenger-moderator curves evidence is presented that the (^1D) electronic state of atomic oxygen is effectively quenched by N_2, N_2O, NO, and CO. The collision model for hot reactions developed by Estrup and Wolfgang, cannot be applied in this case since it does not account for very inelastic collision-events, which determines largely the product distribution in these systems. CO_2, on the other hand, was found to be a very ineffective quencher. Evidence is also presented that supports the thesis that it is primarily $^{15}O(^1D)$ and not $^{15}O(^3P)$ which exchanges for ^{16}O in CO_2, probably through the intermediate CO_3*. The maximum kinetic energy, T, of the ground state recoil ^{15}O atom is $.6 \geq T \leq 1.39$ eV in the systems reported on here. The reactions of atomic ^{13}N with CH_4, C_2H_6, C_3H_8, cyclo-C_3H_6, C_3H_6, and C_2H_4 were studied. The organic substrates were exposed to translationally "hot" ^{13}N atoms and the product distribution measured with respect to varying moderation of the excited ^{13}N by helium. Pressure studies were also performed. NO was added as "scavenger." $HC^{13}N$ is formed by the direct attack of ^{13}N atoms upon the hydrocarbons. Cyanide radicals, formed from the decomposition of vibrationally excited HCN, are the precursors of aceto- and acrylonitrile. ^{13}N and ^{15}O are beta$^+$ emitters with 10 and 2.1 min half-life, respectively. Radio gas chromatographic techniques were employed for product analyses. (Diss. Abstr.)

19014 METHOD AND APPARATUS FOR PROMOTING CHEMICAL REACTIONS BY MEANS OF RADIOACTIVE INERT GAS. Kasamatsu, T.; Ohtsuka, N.; Matsumoto, K. (to Japan Atomic Energy Research Inst.). Canadian Patent 828,736. 2 Dec 1969. Priority date 3 Aug 1966, Japan.

A radioactive inert gas is dissolved in a liquid system under pressure in an amount sufficient to give an absorption dose rate necessary to promote the desired reaction. A nonradioactive inert gas may also be used as a dilutant. Enough radioactive gas is used to give a dose rate of at least 1×10^2 rad/hr. The apparatus consists of a source gas storage, measuring vessel for reactants, a device for removing oxygen from the reactants, pressure resistive reactor, apparatus for separating the source gas from the reaction system, product separator, apparatus for purifying the product, apparatus for recovering unused reactants and solvents, purification apparatus for used source gas, and necessary pumps and pipe line systems. (FSA) (Canada)

19015 HIGH-INTENSITY RADIOLYSIS OF AQUEOUS FERROUS SULFATE–CUPRIC SULFATE–SULFURIC ACID SOLUTIONS. Feng, Paul Y. (Marquette Univ., Milwaukee, Wis. Army Natick Labs., Mass.); Brynjolfsson, Ari; Halliday, John W.; Jarrett, Robert D. J. Phys. Chem.; 74: 1221-7(19 Mar 1970).

The radiolysis of aqueous $FeSO_4-CuSO_4-H_2SO_4$ solutions were studied at dose rates up to ~3×10^{17} eV l^{-1} sec^{-1} (~5×10^{16} rads sec^{-1}). $G(Fe^{3+})$, which equals ~0.7 at low irradiation intensities, increased to ~4 with increasing dose rate, acidity, and the extent of oxygenation. This increase is significantly reduced for systems containing higher concentrations of Cu^{2+}. Kinetic analysis of the results showed that the increase in $G(Fe^{3+})$ values at the higher radiation intensities is due to the reactions $H + H \xrightarrow{k_{12}} H_2$, $H + HO_2 \xrightarrow{k_{15}} H_2O_2$, and $OH + HO_2 \xrightarrow{k_{16}} H_2O_3$, and good agreement between calculated and experimental values is obtained using the following rate constant values (in l mol^{-1} sec^{-1}): $k_{12} = 1.4 \times 10^{10}$, $k_{15} = 2.0 \times 10^{10}$, $k_{16} = 1.1 \times 10^{10}$, and k_{14} (for $H + OH \rightarrow H_2O$) = 2.0×10^{10}. Studies show also that (1) some of the hydrogen atoms are produced in primary radiolytic processes together with solvated electrons, (2) hydrogen sesquioxide, produced by the recombination of OH and HO_2 radicals, is capable of oxidizing four equivalents of Fe^{2+} even in the presence of excess Cu^{2+} ions and therefore the oxidation of Fe^{2+} by H_2O_3 does not proceed via processes which regenerate the HO_2 radical, and (3) radiation-produced hydrogen peroxide is partially decomposed during the pulse, particularly at the higher intensities. (auth)

19016 PULSE RADIOLYSIS OF ALIPHATIC ACIDS IN AQUEOUS SOLUTION. III. SIMPLE AMINO ACIDS. Neta, P.; Simic, M.; Hayon, E. (Pioneering Research Lab., Natick, Mass.). J. Phys. Chem.; 74: 1214-20(19Mar 1970).

The pulse radiolysis of aqueous solutions of some amino acids, glycine, alanine, α-aminobutyric acids, valine and some of their derivatives (including imino diacetic and nitrolotriacetic acids), was studied. Transient optical absorption spectra of aminocarboxyalkyl radicals were produced as a result of dehydrogenation by H atoms and OH radicals, e.g., $\overset{+}{N}H_3CH_2COOH + OH \rightarrow \overset{+}{N}H_3\dot{C}HCOOH + H_2O$. The observed changes in absorption of the transient with variation in pH are attributed to proton dissociation of the carboxyl and amino groups of the radical, which occur at a pH different from that of the parent compound: $\overset{+}{N}H_3\dot{C}HCOOH \xrightarrow{-H^+} \overset{+}{N}H_3\dot{C}HCOO^- \xrightarrow{-H^+} NH_2\dot{C}HCOO^-$. In alkaline solutions, a change in the site of attack by OH radicals is suggested, from the C–H to the N–H bond, with the formation of $\dot{N}HCH_2COO^-$ radicals from glycine. The α-amino-α-carboxyalkyl radicals have absorption maxima in the region 250–260 nm, while the β and γ radicals have maxima well below 240 nm. The previously postulated deamination of amino acids by hydrated electrons was confirmed by direct observation of carboxyalkyl radicals, which in the case of glycine and alanine have absorption maxima at 350 and 340 nm, respectively: $\overset{+}{N}H_3CRH\dot{C}OO^- + e^-_{aq} \rightarrow \dot{C}RHCOO^- + NH_3$. (auth)

19017 ELECTRON REACTIONS IN gamma-IRRADIATED THYMIDINE AND CYSTAMINE. Lenherr, A. D. (Royal Military Coll., Shrivenham, Eng.); Ormerod, M. G. Nature (London); 225: 546-7(7 Feb 1970).

Two model compounds, thymidine and cystamine, were irradiated as frozen glasses of either ethanediol–water or 6M NaOH, and by comparing the ESR and optical absorption spectra the anions produced were identified. Irradiation was below 90°K with ^{60}Co gamma rays, and measurements were made over the dose range 0 to 400 kR. The spectroscopic details of the observed species are discussed. For the ethanediol system, in the presence of 0.05M cystamine there was no evidence of the ESR spectrum of $R-CH_2-S^{\cdot}$, but the cystamine anion was indicated. In the presence of 0.08M thymidine there was evidence for the thymine radical ($TH^{\cdot}$) and the thymine anion (T^-). In the NaOH system, spectra for which are shown, in the presence of 0.08M thymidine there was also evidence for the thymine radical and anion. This system differed from the previous system in that there was a large yield of the thymine radical immediately after irradiation. It is considered that thymidine and cystamine compete for electrons in these systems and under suitable conditions e^-_t, T^- and $(R-S-S-R)^-$ are all present. Electrons appear to transfer to cystamine on warming, and the optical spectra can be used to follow these changes. Identification of the disulphide anion confirms the earlier postulate that the S radicals observed in irradiated proteins are formed by the reaction of electrons produced by irradiation. (UK)

19018 METHOD OF ISOLATION OF ^{233}Pa. Sheidina, L. D.; Kovarskaya, E. N. Radiokhimiya; 11: 721-2(1969). (In Russian).

A method is proposed for the isolation of ^{233}Pa from solutions of ^{237}Np by selective sorption of protactinium by glass from nitric acid solutions. This method allows protactinium to be obtained without a carrier. In addition, the original neptunium solution is not contaminated by reagents. After two months there is again an accumulation of protactinium in the neptunium, which can be removed. (tr-auth)

19019 RADIOCHEMICAL PURIFICATION OF PREPARATIONS OF HIGH-ACTIVITY ^{55}Fe. Danilin, L. D.; Funin, V. N.; Druzhinin, A. A.; Pavlova-Verevkina, A. I. Radiokhimiya; 11: 706-10(1969). (In Russian).

Purification steps were first carried out on iron preparations containing more than 3000 Ci ^{55}Fe, 75 Ci ^{54}Mn, 1 Ci ^{59}Fe, and about 0.5 Ci ^{60}Co. The coefficient of purification of iron from these impurities was greater than 5×10^3. Losses of iron were approximately 10%. It is shown that the stairstep method of elution recommended in the literature reduces the time necessary for elution but does not give sufficient purification as a result of significant washout of the chromatographic band and breakthrough of iron in the form Fe^{3+}. Part of the iron is lost by sorption on the walls of the vessel. (tr-auth)

19020 ELECTRON SPIN RESONANCE SPECTRA OF AN IRRADIATED SINGLE CRYSTAL OF DIFLUOROMALONAMIDE AND HYPERFINE TENSORS OF alpha-FLUORINE COUPLINGS. Iwasaki, M.; Noda, S.; Toriyama, K. (Governmental Industrial Research Inst., Nagoya, Japan). Mol. Phys.; 18: 201-12(1970).

The principal values of the ^{19}F hyperfine tensor for the $\cdot CF(CONH_2)_2$ radical in a γ-irradiated single crystal of difluoromalonamide were determined to be 200, −1, −10 G perpendicular to the radical plane, parallel to the C–F bond, and perpendicular to the C–F bond in the radical plane, respectively. The deviation from axial symmetry of the hyperfine tensor is discussed in comparison with that in other related compounds and it is concluded that the spin polarization of $2p\sigma$ electrons in the C–F bond plays an important role. The polarization factors, Q^F_{CF} and Q^F_{FC}, for the $2p\sigma$ electrons were estimated to be −45 and +233 G, so as to account for the hyperfine tensors of a series of compounds. (auth) (UK)

19021 RADIATION-INDUCED PHENYLATION OF p-BROMOPHENOL IN AQUEOUS SOLUTION. Namiki, Mitsuo; Komiya, Takashi; Kawakishi, Shunro; Aoki, Hiroo (Nagoya Univ., Japan). J. Chem. Soc., D; No. 5, 311-12(4 Mar 1970).

It is stated that new hydroxy-biphenyls and -terphenyls were formed by γ radiolysis of p-bromophenol in aqueous solution. (auth) (UK)

19022 ESR MEASUREMENTS OF IRRADIATED ANION-DOPED POTASSIUM CHROMATE. Schara, M. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia); Sentjurc, M.; Milenkovic, S. M.; Veljkovic, S. R. J. Inorg. Nucl. Chem.; 32: 369-71(Feb 1970).

The hot atom reactions of ^{51}Cr recoils in neutron-irradiated alkali halide- and K_3PO_4-doped potassium chromate were studied by means of ESR measurements. To obtain clearer insight into the role of the radiation damage the ESR spectra of reactor-irradiated samples and of ^{60}Co gamma-irradiated materials were compared, and it was found that the spectra were similar. (auth) (UK)

19023 ELECTRICAL CONDUCTIVITY OF BIOLOGICAL AND ORGANIC COMPOUNDS. PART III. INDUCED CONDUCTIVITY BY GAMMA IRRADIATION IN LONG CHAIN SATURATED HYDROCARBONS, FATTY ACIDS, AND THEIR KETO-DERIVATIVES. Breccia, Alberto; Nucifora, Giuseppina; Dellonte, Sergio (Univ., Bologna). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 46: 569-75(May 1969).

The electric conductivity of solid long-chain and saturated hydrocarbons, ketones, and fatty acids was investigated as a function of the molecular weight. Preliminary results are given on possible correlation of activation energy and specific conductivity with the chain length of these compounds. The conductivity after γ irradiation and conductivity in the liquid state were investigated to get data on the trapping effect and trapping distribution. The resistivity and activation energy values of irradiated compounds are presented, and their behavior did not show a remarkable difference from the same nonirradiated compounds, suggesting the formation of the same kind of carriers, probably free electrons by ionization. (D.H.M.)

19024 EFFECTS DUE TO NONEQUILIBRIUM pH CONDITIONS IN THE RADIOLYSIS OF AQUEOUS SYSTEMS. Fielden, E. M. (Inst. of Cancer Research, Sutton, Eng.); Stevens, G. C.; Phillips, J. M.; Scholes, G.; Willson, R. L. Nature (London); 225: 632-4 (14 Feb 1970).

It is stated that during pulse radiolysis studies of aqueous solutions of pyrimidines and related substances the formation of short-lived organic species by reactions other than those of the free radicals, H, OH, and e^-_{aq}, produced by radiolysis of the solvent was observed. From the evidence presented it is believed that these molecular transient species were the result of acid-base reactions between the pyrimidines and the radiolytic hydroxide ions. Such processes, although unlikely to lead to permanent products, are important in the pulse radiolysis technique, where correct interpretation of the absorption of transients is very important. In the study described N_2O saturated solutions of thymine were irradiated with 0.1- to 2-μs pulses of 2- to 4-MeV electrons, typical doses being 1 kR per pulse. Under these conditions the primarily produced solvated electrons were converted to OH radicals and OH ions and a one-radical system containing OH was effectively produced. The absorption spectrum of the thymine OH adduct (TOH) was studied, and it was found that the transient absorption in solutions at pH 5.5 decayed by a second order process, attributable to the reaction 2 TOH → products. On increasing the pH an additional component became evident, absorbing in the region 270 to 320 nm and decaying rapidly by an apparently first order process, followed by decay of the residual absorption by a second order process observed at lower pH. A plot of the absorption at 300 and 400 nm as a function of pH is shown. A similar state of affairs was observed in uracil–N_2O solutions, but not in systems containing thymidine, thymidylic acid, 1,3-dimethyluracil, 1-methylthymine or 2,4-dimethoxyuracil. These experimental facts can be adequately accounted for by ionization of the pyrimidines on reaction with the radiolytically produced hydroxide ions. The reaction of radioinduced nonequilibrium quantities of OH^- with pyrimidines was clearly demonstrated, and it is stated that such a process should be quite general and should occur wherever the ionization of an acid, or protonization of a base, occurs fast enough, and should be observable spectrophotometrically where there are appreciable spectral differences between the conjugate acid and base forms of the solutes. The possibility also exists for analogous reactions in nonaqueous systems. (UK)

19025 STERILIZATION OF POLYVINYL CHLORIDE AND POLYETHYLENE MATERIALS BY RADIATION. Opletal, Z. (Inst. of Blood Transfusions and Hematology, Brno). Cesk. Farm.; 18: 532-4(Dec 1969). (In Czech).

Poly(vinyl chloride) and polyethylene for medical purposes cannot be sterilized by the standard methods using steam, but can be sterilized by ionizing radiation of an intensity of 2 to 3 Mrad. (JPRS)

19026 SZILARD–CHALMERS ORGANIC YIELDS IN LIQUID AND SOLID ALKYL IODIDES. Ayres, R. L.; Rack, E. P. (Univ. of Nebraska, Lincoln). Radiochem. Radioanal. Lett.; 3: 213-21 (28 Mar 1970). (COO-1617-20).

The radiative neutron capture induced yields of organically bound iodine in the liquid alkyl iodides showed to varying degrees, a dependence on exchange reactions, accompanying γ radiolysis, and phase. In the absence of and/or corrected for the contributions of exchange and radiolysis the $^{127}I(n,\gamma)^{128}I$ induced organic yields in liquid methyl, ethyl, propyl, and butyl iodide were 57, 41, 48, and 48% respectively. The corresponding yields of the polycrystalline alkyl iodide solids at 77 °K were identical to the liquid state values; however, the yields for glassy propyl and butyl iodides were 8 to 12% higher than their corresponding polycrystalline and liquid state values. (auth)

19027 PREPARATION OF CARRIER-FREE ^{51}Cr AND ^{185}W BY MEANS OF (n,γ) RECOIL. Parker, W.; Alarcon, J. Perez (Instituto Venezolano de Investigaciones Cientificas, Caracas). Radiochem. Radioanal. Lett.; 3: 223-6(28 Mar 1970).

An investigation concerning the possibility of obtaining high specific activities of ^{51}Cr and ^{185}W by means of the (n,γ) recoil technique has been carried out. Chemical compounds made were the respective metal carbonyls mixed in various ratios with a chemical scavenger of recoil fragments, which in the present case, was oxalic acid. The recoil activity was analyzed as a function of the concentration of a given carbonyl in the scavenger material and also as a function of irradiation time. The described method can be used for the preparation of carrier-free radioactivity with yields varying between 50% and 100% using irradiation times of four days at fluxes in the order of 10^{13}n $cm^{-2}sec^{-1}$. (auth)

19028 ENRICHMENT OF ^{47}Ca AND ^{132}Cs BY RECOIL SEPARATION USING A CATCHER METHOD. Ebihara, H.; Yoshihara, K. (Japan Atomic Energy Research Inst., Tokai). Radiochim. Acta; 13: 59-60(Feb 1970).

The catcher method was applied to the enrichment of ^{47}Ca produced by the (n,γ) reaction on a natural Ca target. A mixture of a water-soluble Ca salt as a source material and a water-insoluble material as a catcher material was bombarded with neutrons. The ^{47}Ca contained in the catcher as a result of nuclear recoil was separated along with the catcher, and then the ^{47}Ca was separated from the catcher. The yields and enrichment factors were investigated under various conditions for different target systems. Using the system $Ca(OH)_2$–$La_2(C_2O_4)_3$, yields of 20 to 35% and enrichment factors of 5 to 23 were obtained. The method was also applied to the enrichment of ^{132}Cs in natural Cs. (B.L.M.)

19029 PREPARATION OF CARRIER-FREE ^{36}Cl VIA LIGAND RECOIL IN $K_2[ReCl_6]$ AND $K_3[RhCl_6]$. Bell, R.; Stoecklin, G. (Kernforschungsanlage, Juelich, Ger.). Radiochim. Acta; 13: 57-8(Feb 1970).

Carrier-free ^{36}Cl was prepared by the (n,γ) recoil reaction in the ligands of the hexahalo-complexes of Re(IV) and Rh(III), which show remarkable radiation stability. The radioactive chlorine appears in only two forms, the labelled parent compound and the carrier-free Cl. A rather involved anion-exchange procedure (shown schematically) is necessary to separate the ^{36}Cl. The yield of the Cl fraction is 15%. (B.L.M.)

19030 CHEMICAL REACTIONS FOLLOWING NEUTRON IRRADIATION OF KIO_3. Lin, Y.-C.; Wiles, D. R. (Carleton Univ., Ottawa). Radiochim. Acta; 13: 43-8(Feb 1970).

Recoil reactions in neutron-irradiated KIO_3 were studied by thermal and radiation annealing methods. It is found that no change in the retention can be induced by any pretreatment of the crystals before neutron irradiation. A strong radiation annealing effect is observed during the neutron irradiation itself, in that R increases from 74% after 3 min to 83% after one hour's neutron irradiation. Post-recoil annealing effects of heating and of irradiation with uv or with γ rays are found to be interdependent. The observed annealing effects are interpreted as resulting from a series of stepwise reactions involving oxidation of a recoil atom by a mobile electron hole and oxygen ion transfer to the recoil atom from a nearby iodate ion. Support for the stepwise nature of the reaction is drawn from other recent recoil and transfer annealing studies. (auth)

19031 ROLE OF LATTICE DEFECTS IN THE ANNEALING OF CHEMICAL RADIATION DAMAGE. Mohanty, S. R.; Nair, S. M. K. (Utkal Univ., Bhubaneswar, India). Radiochim. Acta; 13: 37-43(Feb 1970).

The role of lattice defects introduced by crushing, compression, doping, and fast-neutron bombardment in the annealing of γ-irradiation damage in lead nitrate was investigated. Compression and crushing of irradiated crystals produce direct recovery and also accelerate the subsequent thermal annealing process. Compression and crushing prior to irradiation also render the material more susceptible to thermal recovery but the effect is completely annulled on heating. The initial damage and the susceptibility to thermal annealing are greater in the case of doped crystals than in that of the untreated salt; the effect depends on the impurity concentration. Annealing is faster with material irradiated with γ rays plus fast (and thermal) neutrons than with γ rays alone. Also defects accelerate photoannealing of chemical radiation damage without affecting the threshold frequency for the occurrence of the annealing. (auth)

19032 PURITY CONTROL OF TARGET MATERIAL FOR RADIOISOTOPE PRODUCTION BY ACTIVATION TECHNIQUE. Nakamura, Haruto; Amano, Hiroshi; Yamabayashi, Hisamichi; Kubota, Masumitsu; Takahashi, Satoko (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 12: 67-73(Feb 1970). (In Japanese).

In order to control effectively the purity of radioisotopes produced by the (n,γ) reaction, previous inspection of target materials is necessary to confirm the absence of impurities that might impair the radioactive purity of the product of neutron irradiation. Neutron activation followed by observations of β decay and γ spectrum was used to obtain a rough estimation of radioactive impurities as a basis on which to perform activation analysis including elaborate chemical separation to determine each of the impurities separately and precisely. This method was applied to 31 kinds of target material including gold. The results have shown that most target materials contain elements of the same periodic group as the major constituent, and that antimony is present in almost every metallic material. The study also proved that ^{24}Na, ^{64}Cu, and ^{56}Mn would be the short-lived radiochemical impurities, and ^{51}Cr, ^{65}Zn, ^{60}Co, ^{192}Ir, and ^{110m}Ag the long-lived impurities most likely to contaminate the radioisotopes produced by (n,γ) reaction. (auth)

19033 PAINTING POLYOLEFIN SUBSTRATES. (to Ford Motor Co. Ltd.). British Patent 1,182,910. 4 Mar 1970. Priority date 4 Dec 1967, United States.

A method of painting polyolefin substrates comprises applying

to the surface of the substrate a liquid coating material having at least two vinyl or vinylidene groups per molecule, exposing the resultant surface to an electron beam, and applying to the irradiated surface a paint that is polymerizable by a second exposure to radiation. The substrate materials may include divinylbenzene, polyhydric alcohol esters of acrylic acid and methacrylic acid, such as ethylene glycol dimethacrylate, trimethylpropane trimethacrylate, tetraethylene glycol dimethacrylate, polyethylene glycol dimethacrylate and the corresponding acrylates, and 1,3-butylene dimethacrylate. (B.L.M.)

Radiochemistry

Refer also to abstracts 19000 and 19002.

19034 (MLM-1709) NATURE OF THE STEADY STATE OF ^{238}Pu IN DILUTE NITRIC AND HYDROCHLORIC ACIDS. Silver, G. L. (Mound Lab., Miamisburg, Ohio). 6 Mar 1970. Contract AT-33-1-GEN-53. 14p. Dep. CFSTI.

The nature of the steady state of plutonium-238 in dilute nitric acid has been reexamined. The concentration of hexavalent plutonium at steady state was lower than previously reported, and depended upon the total plutonium concentration. The use of tristimulus colorimetry for studying plutonium solutions is discussed, and the preparation of solutions of pentavalent plutonium is described. The nature of the steady state of plutonium-238 in dilute hydrochloric acid is mentioned. (auth)

19035 OSNOVY RADIOKHIMII. IZDANIE VTOROE, DOPOLNENNOE. (Fundamentals of Radiochemistry. Second Improved and Expanded Edition). Starik, I. E. Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1969). 648p.

The main questions of contemporary radiochemistry are considered. The state of radioactive elements in liquid, gaseous, and solid phases, the distribution of radioactive elements in heterogeneous systems, and adsorption and electrochemistry of radioactive elements are discussed. The main achievements in radiochemistry over the last decade are reviewed. Topics covered include: state in solution of individual radioactive elements; application of electromigration, dialysis, and diffusion to ion exchange; the distribution of radioactive elements between solution and solid; and electrochemistry of individual elements. (tr-auth)

19036 MOESSBAUER SPECTROSCOPY OF ^{57}Fe FORMED BY ELECTRON CAPTURE FROM ^{57}Co IN THE OXALATES OF COBALT(II) AND POTASSIUM TRIOXALATOCOBALTATE(III). Friedt, Jean-Marie; Asch, Liliane (Centre de Recherches Nucleaires, Strasbourg). Radiochim. Acta; 12; 208-11(Dec 1969). (In French).

^{57}Co-labeled cobaltous (CoC_2O_4 and $CoC_2O_4 \cdot 2\,H_2O$) and cobaltic ($K_3Co(C_2O_4)_3 \cdot n\,H_2O$) oxalates were used as Moessbauer sources. ^{57}Fe is found as Fe^{2+} and Fe^{3+} ions. The anomalous charge states are due to radicals formed in the local autoradiolysis after electronic capture of ^{57}Co. (auth)

19037 YIELDS OF LABELED COMPOUNDS ON IRRADIATION BY BEAMS OF TRITIUM IONS OF TARGETS OF DIFFERENT THICKNESSES. Murav'ev, V. V.; Firsova, L. P. Radiokhimiya; 11; 730-2(1969). (In Russian).

The effects of the geometric parameters of the targets on yields of products were studied. One series of targets was obtained by condensation of chloroform vapors on cooled supports. The thickness of the targets varied from 1.2×10^{-4} to 6.5×10^{-2} g/cm^2. Sandwich targets, prepared by condensation of benzene layers and chloroform layers for various thicknesses, were also bombarded. Studies were also made on the irradiation of homogeneous mixtures of chloroform and iodine. (tr-auth)

19038 EFFECTS OF CURRENT DENSITY OF T^+ IONS ON DISTRIBUTION OF ACTIVITY IN PRODUCTS FROM REACTION OF TRITIUM WITH BENZENE. Kuklin, Yu. S.; Firsova, L. P. Radiokhimiya; 11; 729-30(1969). (In Russian).

It was shown that with an increase in current density of T^+ ions the activity of products of the hydrogenation of benzene decreases. The activity of benzene increased noticeably in the range from 0.015 to 0.8 μA/cm^2. The yields of heavily labeled products went through a maximum and decreased smoothly. Reaction mechanisms are considered. (tr-auth)

Separation Processes

Refer also to abstracts 18888, 18899, 18900, 18906, 18908, 18913, 19018, 19019, and 19270.

19039 (AERE-R-5268) EFFECTS OF FISSION PRODUCT HEAT ON THE PRODUCTION CAPACITY OF THE FINGAL PROCESS. Davis, Wallace Jr. (Atomic Energy Research Establishment, Harwell (England)). Sep 1967. 211p. Dep. CFSTI (U. S. Sales Only).

A mathematical model of heat transfer, mass transfer, and chemical reactions occurring in a FINGAL process vessel was solved by a finite difference method using experimentally obtained physical properties for the system. Calculations suggest that the steady state production rate of the FINGAL process will be considerably greater in the presence of 1-year-old fission products than in their absence. A 50% increase should be readily attainable and with careful design of the furnace, the production rate may be doubled. (auth)

19040 (DOCKET-50201-32) WEST VALLEY REPROCESSING PLANT. Head End Ventilation System. Final Safety Analysis Report. (Nuclear Fuel Services, Inc., West Valley, N. Y.). Mar 1970. 40p. Dep. CFSTI.

A safety analysis for the head end ventilation system is described. The system was evaluated for effects of releases of radioactive materials resulting from normal operations, maloperation conditions, and from a postulated abnormal event. (M.C.G.)

19041 (DOCKET-50268-5) MIDWEST FUEL RECOVERY PLANT. Design and Analysis, Suppl. 3. (General Electric Co., San Jose, Calif. Nuclear Energy Div.). 5 Mar 1970. 64p. Dep. CFSTI.

Information is presented on the system of quality assurance plans and procedures being followed in the program for design, construction, and operation of the plant. Classification of plant systems, structures, and components is discussed. Quality assurance requirements and records are considered. (M.C.G.)

19042 (DOCKET-50332-7) BARNWELL NUCLEAR FUEL PLANT. Addendum No. 2 to Safety Analysis Report. (Allied-Gulf Nuclear Services, Florham Park, N. J.). 16 Mar 1970. 94p. Dep. CFSTI.

Information is presented on the safety analysis of the Barnwell Plant in support of the application for construction and operation of the plant. (M.C.G.)

19043 (DOCKET-50332-8) BARNWELL NUCLEAR FUEL PLANT. [Safety Analysis Report], Amendment 4. (Allied-Gulf Nuclear Services, Florham Park, N. J.). 16 Mar 1970. 64p. Dep. CFSTI.

Information on the partnership between Allied Chemical Nuclear Products, Inc. and Gulf General Atomic Incorporated for construction and operation of the Barnwell Plant is presented. The annual financial report of Gulf Oil Corporation is included. (M.C.G.)

19044 (IBK-832) TWENTY YEARS OF CHEMISTRY ASSOCIATED WITH THE NEEDS AND UTILIZATION OF NUCLEAR REACTORS AT THE BORIS KIDRIC INSTIUTE OF NUCLEAR SCIENCES, VINCA, YUGOSLAVIA. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). 1969. 61p. (In Slovenian). Dep. CFSTI (U. S. Sales Only).

Topics covered include: radiochemistry, hot atom chemistry, production of radioisotopes, fuel reprocessing, chemistry of transuranium elements, treatment of radioactive liquid wastes, purification of cooling water for nuclear reactors using ion exchangers, research in deuterium enrichment, and chemical dosimetry of the RA reactor at Vinca. (M.C.G.)

19045 (IN-1293) SAFETY ANALYSIS REPORT FOR THE ICPP DENITRATION PROCESS. Offut, G. F. (ed.) (Idaho Nuclear Corp., Idaho Falls). Jan 1970. Contract AT(10-1)-1230. 39p. Dep. CFSTI.

A process description of the product denitration facility being installed at the Idaho Chemical Processing Plant is presented. Major equipment and instrumentation are described. Safety analyses for nuclear safety, radioactive nuclide emission, NO_2 emission, and product packaging are discussed, and it is concluded that operation of the process will not introduce hazards to personnel either on or off the NRTS. (auth)

19046 (INR-1115) INFLUENCE OF TEMPERATURE AND RESIN CROSS-LINKING ON ION EXCHANGE REACTIONS AND CHROMATOGRAPHIC SEPARATIONS. Dybczynski, Rajmund (Institute of Nuclear Research, Warsaw (Poland)). 1969. 184p. (In Polish). Dep. CFSTI (U. S. Sales Only).

Examination of equilibria and the thermodynamics of cation exchange of alkali metals on sulfonic and phenolsulfonic cation exchange resins, and anion exchange of the rare earth complexes with EDTA and DCTA on strongly basic anion exchange resins supplied enough data for the general characterization of the influence of temperature and resin crosslinking on ion exchange equilibria. The effect of these factors on the dynamics of chro-

matography was also investigated and the general classification of the possible changes in resolution in relation to changes of separation factor and the plate height is presented. It is shown that the theories being currently in use in ion exchange chromatography in some cases fail to give an exact description of the elution process. It is also shown that the commonly used empirical rules predicting the effect of temperature and resin cross linking on ion exchange separation do not have a universal meaning. The possibility of reasoning about the nature of bond between counter ion and resin functional group, as well as about the structure of complex ions in solution from the analysis of respective thermodynamic functions was pointed out. (auth)

19047 (NLCO–1057) IMPROVEMENTS IN THE TBP EXTRACTION PROCESS FOR URANIUM CONCENTRATES AND RESIDUES. Cavendish, J. H.; Leist, N. R. (National Lead Co. of Ohio, Cincinnati). [13 Mar 1970]. 10p. (CONF-700203–1). Dep. CFSTI.

From American Institute of Mechanical Engineers Meeting, Denver, Colo.

Significant advances have been made in uranium concentrate purification technology in the past 25 years. These changes have led to the present low-cost-high-productivity flowsheet employed by the National Lead Company of Ohio for the purification of domestic concentrates. Responsible for increased productivity and lower operating costs are: equipment modifications in the concentrate digestion system; operating condition and equipment changes in the primary uranium extraction section, the extract scrubbing system and the uranium reextraction system; and new solvent treatment techniques. The modified system has a greater tolerance for impurities in ore concentrates and produces a much purer product with an increased reliability factor. (auth)

19048 (NP–18167) DESIGN OF AN ELECTROLYTIC CELL AND PLAN OF A TEST STAND FOR DIRECT REDUCTION OF Pu(IV). Roth, B. F.; Roos, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Dec 1969. 23p. (In German). Dep. CFSTI (U. S. Sales Only).

The direct electrolytic reduction of plutonium in process streams in the 1B battery is an effective method for separation of uranium and plutonium. The greatest advantages of this method are observed at high plutonium concentrations such as occur in the reprocessing of fuel from fast breeder reactors. (tr-auth)

19049 (ORNL–4365) UNIT OPERATIONS SECTION QUARTERLY PROGRESS REPORT, APRIL–JUNE 1968. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 64p. Dep. CFSTI.

Separate abstracts were prepared for two of the three sections. The remaining section reports progress on the separation of phenylalanine and tyrosine tRNAs and the separation of methionine and valine tRNAs. (D.H.M.)

For abstracts of individual sections see: 19050 and 19484.

19050 (ORNL–4365, pp 21-61) MOLTEN-SALT REACTOR PROCESSING STUDIES. (Oak Ridge National Lab., Tenn.).

Progress is reported on several operations that may be used in a close-coupled processing facility for removing fission products, corrosion products, and fissile materials from the molten fluoride mixture; this facility will be an integral part of the reactor system. Included are the MSRE distillation experiment; frozen-wall corrosion protection; simulated molten salt–liquid bismuth contactor; and electrolytic cell development. (D.H.M.)

19051 (ORNL-TM–2793) ORNL EXPERIMENTS ON THE BEHAVIOR OF TRITIUM DURING HEAD-END PROCESSING OF IRRADIATED REACTOR FUELS. Goode, J. H.; Vaughen, V. C. A. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 25p. Dep. CFSTI.

The behavior of tritium, a ternary fission product having an approximate 0.01% yield, was investigated in hot-cell tests of several pre-solvent extraction operations for power reactor fuel processing using various oxide and carbide specimens. Generally, less than 5% of the calculated yield of tritium was found in samples of fuel rods that had been operated at linear heat ratings greater than about 3 to 4 kw/ft. Further efforts to determine the fate of the remaining tritium, both during irradiation and fuel reprocessing, are planned. (auth)

19052 (ORNL-TM–2886) THORIUM FUEL CYCLE DEVELOPMENT PROGRESS REPORT NO. 7, FEBRUARY 1970. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 30p. Dep. CFSTI.

Research and development are reported on head-end reprocessing, refabrication, materials irradiation, and ^{233}U reprocessing. (D.H.M.)

19053 (ORNL-TM–2888) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, October 1–December 31, 1969. Arnold, W. D.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). 27 Feb 1970. Contract W-7405-eng-26. 18p. Dep. CFSTI.

In cementation tests with a liquor containing radionuclides leached from underground test shot debris, only ^{106}Ru contaminated the cement copper product. Small amounts of ^{125}Sb and ^{137}Cs were dissolved from the debris but did not cement with the copper. When Green River oil shale was heated with tritiated hydrogen, the shale and the oil subsequently retorted from the shale were contaminated with tritium. Much lower contamination resulted from exposure of the shale to tritiated methane or tritiated ethane. The tritium contamination of the shale and oil increased steadily as the exposure time of the shale to tritiated hydrogen was increased to 25 days. About 60% of the tritiated hydrogen was removed from a contaminated shale sample by treating it for 6 days at 95°C with a moist gas stream. The apparatus for measuring the distribution of radioactive constituents of natural gas samples was completely assembled and subjected to preliminary checking and calibration. A final calibration is being made with a previously-analyzed sample of gas from the Gasbuggy well. In small-scale tests simulating operations in a natural gas processing plant, very small but measurable tritium contamination of kerosene occurred when it was exposed at elevated pressure to tritiated methane or tritiated ethane for 30 to 45 days. The contamination was greater with ethane than with methane. In both cases, the tritium concentration of the kerosene increased steadily with increasing exposure time. (auth)

19054 (TID–25356) FUEL FOR THE ATOMIC AGE. COMPLETION REPORT ON ST. LOUIS-AREA URANIUM PROCESSING OPERATIONS, 1942–1967. (Fleishman-Hillard, Inc., St. Louis, Mo.). 30 Sep 1967. Contract W-14-108-eng-8; Subcontract 25188-M. 186p. Dep. CFSTI.

For Mallinckrodt Chemical Works, Weldon Spring, Mo., Uranium Div.

A history of the Government's uranium operations in the St. Louis area is reported. Officially, it is a "completion report" describing Mallinckrodt's operations from July 1, 1942, through June 30, 1967, under Contract No. W-14-108-ENG.-8 for the United States. To provide perspective, significant events and activities from Martin Heinrich Klaproth's discovery of uranium in 1789 to Mallinckrodt's initial involvement in uranium-processing research in the spring of 1942 are discussed. It continues through the termination of the company's standby contract with the AEC in June, 1967. A chart summarizing the major contributions of the Mallinckrodt organization to the Government's uranium processing and development efforts in the St. Louis area during the 25-year period is given. (228 references). (P.C.H.)

19055 THE EXTRACTION OF ZIRCONIUM(IV) FROM HYDROCHLORIC ACID SOLUTIONS BY TRICAPRYLMETHYLAMMONIUM CHLORIDE. Sato, Taichi; Watanabe, Hiroshi (Shizuoka Univ., Hamamatsu, Japan). Anal. Chim. Acta; 49: 463-71 (Mar 1970).

The partition of zirconium(IV) between hydrochloric acid solutions and organic solutions of a quaternary ammonium compound was investigated under different conditions. Infrared and high-resolution nuclear magnetic resonance spectroscopy were used to examine the composition of the extracted complex. The effects of organic solvent on the extraction were also examined. The mechanism of zirconium extraction is discussed. (auth)

19056 DEVICE FOR THE ION-EXCHANGE SEPARATION OF Zr AND Hf. Charlot, G.; Hure, J.; Tremillon, B.; Saint-James, R. (to CEA). German Patent 1,288,576. 6 Feb 1969. Priority date 19 Apr 1960, France.

A method is described for the separation of zirconium from hafnium by use of a strongly basic anion exchange resin loaded with bisulfate anions. Displacement of the zirconium is followed by regeneration of the resin by elution. (M.C.G.)

19057 ANION-EXCHANGE EQUILIBRIA IN ALKALINE MEDIA. Hirsch, Roland F.; Portock. John D. (Seton Hall Univ., South Orange, N. J.). Anal. Chim. A a; 49: 473-9 (Mar 1970).

The distribution ratios of a large number of species are reported for anion exchange from strongly alkaline solutions. The strongly basic macroreticular anion exchanger, Amberlyst A-29 was used. The elements in the oxidation states studied were classified by their ion-exchange behavior. The degree to which a species is absorbed by the resin depends on whether it exists in an anionic form and whether it is hydrated or forms hydrogen bonds with the water in the aqueous solution. While working with hydroxide solutions presents some practical problems, the sizeable differences in distribution coefficients for several groups of ions may be analytically useful. (auth)

19058 EXTRACTION OF LEAD AND SCANDIUM BY BIS-(2-ETHYLHEXYL) PHOSPHATE. Erdei, M.; Gromov, B. V. Tr. Mosk. Khim.-Tekhnol. Inst.; No. 58, 71-5(1969). (In Russian).

Lead and Sc are extracted by bis(2-ethylhexyl) phosphate in kerosene at 25°C and at an ionic strength of 1.8 ($NaClO_4$–$HClO_4$). The compounds extracted have the formulas $Sc(HA_2)_3$ and $Pb(HA_2)_2$, where H_2A_2 is the dimeric reagent molecule. The effects of Cl^-, NO_3^-, and SO_4^{2-} on the extraction of Sc and Pb and the effect of the ionic strength (0.11 to 1.8) on the solubility product of $PbSO_4$ have been studied. (Referativnyi Zh.)

19059 TREATMENT OF SOUTH ALLIGATOR VALLEY URANIUM ORES. Murray, R. J.; Fisher, W. J. (United Uranium No Liability, Melbourne). At. Energ. Aust.; 13: 1-8 (Jan 1970).

An abstract of this article, prepared from the published conference proceedings, appeared as NSA 23: 40826. (Australia)

19060 STUDY OF TRANSIENT STATE IN MIXER-SETTLERS. URANIUM EXTRACTION. Rouyer, Hubert (Ecole Centrale des Arts et Manufactures, Chatenay-Malabry, France); Kikindai, Tivadar. Compt. Rend., Ser. C; 270: 271-4(19 Jan 1970). (In French).

The transient state induced in mixer-settlers by a step disturbance of the input concentrations was studied semiempirically. The results of the experiments are compared to those of a calculated simulation. (France)

19061 MECHANISM OF SELECTIVE SORPTION OF MICROQUANTITIES OF MOLYBDENUM(VI) BY ACTIVE CARBONS. Tarkovskaya, I. A.; Shevchenko, S. I.; Chernenko, A. N. Ukr. Khim. Zh.; 35: 1160-7(1969). (In Russian).

On the basis of data obtained on the character and mechanism of adsorption of Mo(VI) for the sorption of trace impurities of Mo from complex mixtures, a selective cation exchanger carbon, which was oxidized by air and had a relatively coarse porous structure, is recommended. It was found that 50 to 60% of the molybdenum could be desorbed by water, 80 to 90% by weakly alkaline solutions, but for complete desorption it was necessary to use a concentrated base. (tr-auth)

19062 EXTRACTION OF PROTACTINIUM FROM MOLTEN SALT MIXTURES INTO BISMUTH–TIN SOLUTION. Grimes, W. R.; Moulton, D. M.; Shaffer, J. H. (to U. S. Atomic Energy Commission). U. S. Patent 3,495,975. 17 Feb 1970.

An improved process for reprocessing spent molten fluoride salts containing iron impurities of bred-in protactinium values comprised contacting the salts at a temperature of about 650°C with a bismuth–tin metal solution containing minor amounts of a metal reductant. (AEC)

19063 METHOD AND COMPOSITION FOR DECONTAMINATION OF STAINLESS STEEL SURFACES. Weed, R. D. (to U. S. Atomic Energy Commission). U. S. Patent 3,496,017. 17 Feb 1970.

The tenacious magnetite film containing radioactive contaminants, which forms on stainless steel heat exchange surfaces of nuclear reactors, is removed by a two-step treatment. The first step utilizes a hot, alkaline, aqueous solution of potassium permanganate. The second utilizes a hot aqueous solution of oxalic acid, dibasic ammonium citrate, ferric sulfate or nitrate, and diethylthiourea. (AEC)

19064 IMPROVEMENTS IN APPARATUS FOR THE REMOVAL OF SHEATHS FROM NUCLEAR FUEL ELEMENTS. Catlin, Jack Robert; Moorhouse, Dennis; Connop, Robert Patrick Phillips (to United Kingdom Atomic Energy Agency). British Patent 1,180,033. 4 Feb 1970. Filed 10 Jan 1967.

The apparatus described comprises four symmetrically disposed cutting blades or wheels for scoring the sheath longitudinally, a die for stripping the scored sheath from the fuel member, and means for breaking up the sheath as it is stripped from the fuel. (UK)

19065 ELECTROLYTIC DISSOLUTION OF METALS FROM URANIUM. Raviv, Samuel; Rabinovitz, Elsa; Malkiely, Shimon (to Ministry of Defence). U. S. Patent 3,490,999. 20 Jan 1970. Filed 26 Sep 1967.

An electrolytic dissolution process for separating electronegative metals and metal alloys of the kind that are passivated by HNO_3 comprises connecting the metal as a cathode into an electrolytic circuit in which the electrolyte is HNO_3. (Offic. Gaz.)

19066 ISOLATION OF STABLE ISOTOPES OF NEODYMIUM FROM THE SOLUTION OF FISSION PRODUCTS OF URANIUM BY ION EXCHANGE FOR ISOTOPE DILUTION MASS SPECTROMETRIC ANALYSIS. Krtil, J.; Moravec, A.; Mencl, J.; Alexa, J. (Inst. for Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 3: 113-20(12 Mar 1970).

A rapid, specific, and effective separation procedure was developed for the isolation of trace amounts of neodymium from solutions of nuclear fuel for its measurement by isotopic dilution mass spectrometry. (auth)

19067 STUDIES OF EXTRACTION EQUILIBRIUMS IN THE SYSTEM BIS(2-ETHYLHEXYL) PHOSPHATE–OCTANE–TM^{3+}–H^+–Na^+–ClO_4^-–WATER. Mikhailichenko, A. I. Radiokhimiya; 11: 660-8(1969). (In Russian).

The extraction of Tm from perchlorate solutions by low concentrations of bis(2-ethylhexyl) phosphate in octane was studied and equilibrium constants are included. (R.V.J.)

19068 EXTRACTION OF COMPLEX ACIDS BY OXYGEN-CONTAINING SOLVENTS. X. THE MECHANISM OF EXTRACTION OF HEXAVALENT POLONIUM FROM SOLUTIONS OF HYDROCHLORIC ACID. Iofa, B. Z.; Yushchenko, A. S. Radiokhimiya; 11: 668-72(1969). (In Russian).

The extraction of polonium from solutions of HCl by ketones, alcohols, or complex esters was studied. A mechanism is proposed and established. The formation constant of the higher chloride complex of Po(VI) was calculated to be 16.4. (tr-auth)

19069 EXTRACTION OF COMPLEX ACIDS BY OXYGEN-CONTAINING SOLVENTS. XII. THE EXTRACTION OF POLONIUM FROM SOLUTIONS OF HYDROBROMIC ACID. Iofa, B. Z.; Yushchenko, A. S. Radiokhimiya; 11: 677-82(1969). (In Russian).

The extraction of divalent and tetravalent polonium from HBr solutions by 1-hexanol, 2,4-dimethyl-3-pentanone, pentyl acetate, and butyl ether was studied. An extraction mechanism is proposed and confirmed. The formation constants of the higher bromide complexes of polonium(II and IV) were found to be 52 and 274, respectively. (tr-auth)

19070 BEHAVIOR OF MICROQUANTITIES OF AMERICIUM IN THE PROCESS OF COAGULATION DECONTAMINATION OF WASTE WATER. Pavlov-Verevkin, B. S. Radiokhimiya; 11: 732-4(1969). (In Russian).

On coagulation treatment of waste water that contains ^{241}Am, a coefficient of purification equal to 300 to 400 was obtained. Coprecipitation of americium with iron hydroxide has an adsorptive character. (tr-auth)

19071 STUDY OF THE INTERACTION OF RADIOACTIVE MICROCOMPONENTS IN AQUEOUS SOLUTIONS WITH ALKYL ARYLSULFONATES BY THE METHOD OF FOAM FORMATION. III. THE INFLUENCE OF COMPLEX FORMATION ON THE ABSORPTION OF ^{90}Y AND ^{90}Sr BY ALKYL ARYLSULFONATE FOAMS. Pushkarev, V. V.; Berezyuk, V. G. Radiokhimiya; 11: 682-8(1969). (In Russian).

The reactions of ^{90}Y and ^{90}Sr with alkyl arylsulfonates in the presence of oxalic and citric acids and Trilon B were studied by the method of foam formation. The addition of these complexing agents sharply decreased the degree of transfer of the ^{90}Y and ^{90}Sr to the foam fraction. The degree of extraction passed through a maximum with the addition of the complexing agents, whereas no maxima were observed without these additions. (tr-auth)

19072 INVESTIGATION OF COMPLEX FORMATION IN THE EXTRACTION SYSTEM UO_2^{2+}–HF–HNO_3–TOA BY SPECTROSCOPIC METHODS. Vdovenko, V. M.; Lipovskii, A. A.; Nikitina, S. A.; Shcherbakova, L. L.; Shcherbakov, V. A. Radiokhimiya; 11: 651-60(1969). (In Russian).

The electronic and infrared spectra and the ^{19}F NMR spectra in organic solutions of uranyl ions containing trioctylammonium fluoride or nitrate were measured and it was discovered that mixed fluoride-nitrate compounds of uranium occur in the solution. The possible structure of these compounds is discussed and it is shown that fluoride ions in the observed polymer compounds form bridges between atoms of uranium. At ratios of $F/U \geq 3$, only pure fluoride compounds are formed. It is shown that the presence of maxima on the curve describing the relation between the coefficients of distribution of uranium on extraction from HF–HNO_3 mixtures to the concentration of HNO_3 is related to the formation of mixed fluoride-nitrate compounds. (tr-auth)

19073 COMPLEX FORMATION OF AMERICIUM WITH DECANOHYDROXAMIC ACID. Voden, V. G.; Obukhova, M. E.; Pushlenkov, M. F. Radiokhimiya; 11: 644-50(1969). (In Russian).

Mechanisms are proposed for the two reactions in the extraction of americium from its acetate solution by decanohydroxamic

acid. General constants for the reactions were obtained by calculation of the solvation of the complexes formed. The magnitudes of the constants of formation of acetate complexes of americium in aqueous solutions were confirmed. (tr-auth)

19074 EXTRACTION OF COMPLEX ACIDS BY OXYGEN-CONTAINING SOLVENTS. XI. EXTRACTION OF TELLURIUM(IV) FROM HYDROBROMIC ACID AND HYDROGEN IODIDE ACIDS. Iofa, B. Z.; Ridvan, M. Radiokhimiya; 11: 673-7(1969). (In Russian).

Equilibrium coefficients for the distribution of tellurium IV between solutions with various concentrations of HBr and HI and certain alcohols, ketones, and simple and complex ethers were determined. It is shown that tellurium extractability increased in transition from HCl to HBr and further to HI and decreased in the following series: ketones > alcohols > complex ethers > simple ethers. (tr-auth)

19075 RADIOCHEMICAL SEPARATION OF ^{234}Th ON ZEOKARB-225 EXCHANGE RESIN USING m-NITROBENZOIC ACID AS ELUTING AGENT. Sethi, S.; Rai, R. S. (Inst. of Tech. and Science, Pilani, India). Z. Anal. Chem.; 249: 186(26 Feb 1970).

Thorium forms a complex with m-nitrobenzoic acid in the ratio of 1 : 4, and this fact was utilized for an ion exchange separation of thorium using Zeokarb-225 resin. (D.H.M.)

19076 SEPARATION OF RARE EARTHS BY CHROMATOGRAPHY ON ION EXCHANGERS. II. SEPARATION AND ANALYSIS OF THE PAIR EUROPIUM-GADOLINIUM. Brunisholz, G.; Roulet, R. (Univ., Lausanne, Switzerland). Helv. Chim. Acta; 53: 126-30(1970). (In French).

A displacement chromatography technique is described for the separation of europium and light rare earths using the eluent ethylenediaminetetraacetate buffered by ammonium acetate giving a determined pH in the separation columns. This method gives concentrations up to 20 g of pure rare earth oxides per liter of eluate. A chromatographic method of analysis of europium in presence of other rare earths is also described. (auth)

19077 SORPTION OF ^{134}Cs FROM SIMULATED WASTE SOLUTIONS BY INSHAS SANDS. Abdel-Gawad, A. S.; Metry, E.; Farah, M. Y. (Atomic Energy Establishment, Inshas, United Arab Republic). Atompraxis; 16: 44-6(Jan-Feb 1970).

The capability of Inshas sand to sorb ^{134}Cs from simulated waste solutions was tested. Sand column beds were investigated to determine 50% breakthrough volume and to test the applicability of the data obtained from short laboratory columns to longer ones. Prediction of breakthrough behaviour of cesium was shown to be possible on the basis of the theoretical plate concept as treated by Glueckauf. (auth)

19078 EXPERIMENTS ON SEPARATION OF ZIRCONIUM-PHOSPHORUS IN ZIRCONIUM ACID PHOSPHATE. Chassaing, B[rigette]. Rev. Chim. Miner.; 6: 1071-9(1969). (In French).

Diphosphatozirconic acid can be used to separate zirconium and hafnium from certain metals the phosphates of which are soluble; however, the zirconium must be purified from large amounts of retained phosphorus. Three procedures investigated are: treatment of the pastes with sodium hydroxide solutions (the sodium hydroxide is recovered and used to precipitate zirconia in the next step, and in most favorable cases the gained zirconia do not contain more than 1,000 ppM phosphorus; dissolution of phosphorus rich zirconia in a sulfuric medium (in certain acidity conditions, almost the whole of the phosphorus stays as a residue and the precipitated zirconia does not contain more than 200 to 300 ppM phosphorus); and separation through selective extraction (the zirconia is extracted from a nitric solution with a mixture of tributylphosphate and white spirit, the phosphorus stays in the aqueous phase of convenient acidity, and the zirconia contains less than 100 ppM phosphorus). (auth)

19079 PROCESS FOR SEPARATING EUROPIUM FROM OTHER RARE EARTHS. Smetana, Otto (to Treibacher Chemische Werke Aktiengesellschaft). U. S. Patent 3,486,843. 30 Dec 1969. Priority date 7 Jul 1966, Austria.

Europium present in an aqueous solution of rare earth sulfates is reduced to its bivalent form, then precipitated by the addition of Sr^{2+} or Ba^{2+} ions, and recovered from the sulfate precipitate. (Official Gazette)

19080 INVESTIGATIONS ON THE SEPARATION OF SOME LANTHANIDES AND ACTINIDES BY EXTRACTION CHROMATOGRAPHY IN THE SYSTEM BIS(2-ETHYLHEXYL) ORTHOPHOSPHATE-HYDROCHLORIC ACID. Stronski, Ignacy (Institut fuer Kernphysik, Krakow). Radiochim. Acta; 13: 25-31 (Feb 1970). (In German).

The extraction and reextraction processes of some chlorides of lanthanides and actinide were investigated by partition chromatography. Chromatographic columns with powdered poly(trifluoromonochloroethylene) (KEL-F) supporting bis(2-ethylhexyl) orthophosphate (HDEHP) were used. The optimal conditions of separation of trace amount of trivalent or divalent ions of Eu-Gd, Eu-Tb, Ho-Er, Tm-Lu, Yb-Lu as well as (Am + Cm)-Eu, (Am + Cm)-UO_2, and (Am + Cm)-PuO_2 were found. The HCl concentration dependence of the distribution coefficients of chlorides of Am, Cm, Eu, Gd, and Tm were investigated by the static extraction method. The influence of irradiation with γ quanta from ^{60}Co nuclides on the solid supports and extractants were also studied by the method of potentiometric titration of acidic radiolysis products. (auth)

19081 THE INFLUENCE OF THE COMPLEX FORMATION ETWEEN OCTANOL AND LONG-CHAIN-QUATERNARY AMMONIUM NITRATES IN o-XYLENE AND n-DODECANE ON THE EXTRACTION OF Pu(IV). Bac, R. (Brocades Research Lab., Haarlem). Radiochim. Acta; 13: 16-25(Feb 1970).

The extraction of trace amounts of Pu(IV) by quaternary ammonium nitrates (Q's) from 3M HNO_3 was studied. The Q's, tridodecylmethylammonium nitrate (TLMA) and hexadecyldimethylbenzylammonium nitrate (HDDMBA) were used in o-xylene or in n-dodecane solutions. Special attention was given to the effect of n-octanol (O), present as a solvent modifier, on the metal extraction. In octanol-modified o-xylene, Pu(IV) extraction data could be explained on the basis of the formation of complexes between monomeric Q and the octanol monomer and tetramer species. In octanol modified n-dodecane solutions, monomeric Q forms a complex with the octanol trimer species. By a curve-fitting technique the equilibrium constants of the following reactions were determined: $Q + O \rightleftharpoons QO$ (K_{QO}), $Q + O_3 \rightleftharpoons QO_3$ (K_{QO_3}), and $Q + O_4 \rightleftharpoons QO_4$ (K_{QO_4}). It was found that these constants are $K_{QO} = 28\ M^{-1}$ and $K_{QO_4} = 230\ M^{-1}$ for both TLMA and HDDMBA in o-xylene + octanol, $K_{QO_3} = 1500\ M^{-1}$ for TLMA in n-dodecane + octanol and it is estimated that $K_{QO_3} = 630\ M^{-1}$ for HDDMBA in n-dodecane + octanol. (auth)

19082 CHEMICAL TECHNOLOGY OF THE NUCLEAR ENERGY INDUSTRY. Lopez Perez, B.; Otero de la Gandara, J. L. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid); 13: 396-405(Sep-Oct 1969). (In Spanish).

Topics covered include: beneficiation of radioactive minerals and obtaining of concentrates, obtaining nuclear purity and preparation of intermediate compounds, cascades for isotope separation, problems of critical mass in installations, reprocessing of irradiated fuels, processing of radioactive residues, and new aspects in fluid dynamics and heat transfer. (M.C.G.)

19083 RADIOCHEMICAL SEPARATIONS ON INSOLUBLE FERRICYANIDES. Mehra, M. C. (Univ. of Moncton, New Brunswick, Can.). Radiochem. Radioanal. Lett.; 3: 201-11(28 Mar 1970).

The insoluble ferricyanide of iron(II) has been found to be an efficient and rapid exchanger for ^{137}Cs from an aqueous medium. The cesium recovery remains quantitative under diverse experimental conditions of acidity, dilution, inactive carrier concentration, and dissolved solid contents. In addition, optimum conditions have been established for the quantitative precipitation of ferricyanides by the radiometric technique. A short radiochemical procedure is proposed for the concentration and routine monitoring of ^{137}Cs and other activities in laboratory waste effluents. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 18905, 19099, and 19121.

19084 (PNE–1013) HYDROLOGY OF PROJECT GASBUGGY SITE, RIO ARRIBA COUNTY, NEW MEXICO. Mercer, Jerry W. (Geological Survey [Denver, Colo.]). Sep 1969. 45p. (PNE-G–60). Dep. CFSTI.

The project Gasbuggy nuclear experiment of 26 kilotons design yield was detonated at 4,240 feet below ground surface at the Gasbuggy site in the SW¼ sec. 36, T. 29 N., R. 4 W., Rio Arriba County, New Mexico, on Sunday, December 10, 1967, 12:30 Mountain Standard time. The experiment was designed to increase the permeability of a low-yield natural gas formation. The Ojo Alamo Sandstone reportedly was the only aquifer within probable range of fracturing at the site. Thus, hydrologic testing in the exploratory holes was in that sandstone between approximate depths of 3,475 and 3,650 feet. Data from packer tests determined that the average transmissivity of the Ojo Alamo Sandstone is less than 3 gallons per day per foot and that relative specific capacities are less than 0.03 gallon per minute per foot of drawdown. Tests also showed that the hydraulic pressure in the Ojo Alamo Sandstone is greater than the gas pressure in the Pictured Cliffs Sandstone. These data indicated that if the nuclear detonation fractured the Ojo Alamo Sandstone, water from this sandstone would fill the chimney or detonation chamber at an estimated rate of less than half a foot per day. The low transmissivity of the sandstone aquifer would hinder the transport of radioactive contaminants in water in the aquifer, even if momentary overpressure in the explosion cavity caused contaminants to reach the Ojo Alamo Sandstone. Observation of water levels in wells and measurements of yields of springs preshot, at shot time, and postshot indicate that the detonation did not significantly or permanently disturb nearby water wells or springs. (auth)

19085 YADERNAYA GEOFIZIKA. TRUDY, VYPUSK 7. (Nuclear Geophysics. Transactions, Issue 7). Alekseev, F. A. (ed.). Moscow; Izdatel'stvo Nedra (1969). 264p.

Twenty two articles are included on the theory of nuclear geophysics and gamma–gamma and neutron diffusion methods of exploration. Data on mathematical modeling of γ–γ logging are presented. Curves of the time distribution of thermal neutrons and γ-quantum capture in homogeneous media, inelastic neutron scattering and anisotropic elastic scattering in the center-of-mass calculations by the Monte Carlo method in neutron logging, and theoretical analysis of the efficiency of using the cosmic radiation muon component for resolving problems in geophysics are included. The methods, apparatus, and instrumentation used for quantitative determination of ore content using Po–Be and Po–B sources, for γ–γ logging of underground oil and gas deposits and the efficiency of γ- and drill-hole vapor of γ-spectrometers are discussed. Studies of ore deposits by the fission tracks of spallation elements are discussed including dosimetry of neutron fluxes by the uranium fission product tracks and the determination of the efficiency coefficient of various materials used in recording tracks of fission fragments. Geophysical and geochemical studies of super-depth drill holes are also described. (R.V.J.)

19086 STUDY ON THE PHYSICO-CHEMICAL CHARACTERISTICS OF THE TERRAINS SURROUNDINGS THE C. S. N. CASACCIA IN RELATION TO SAFE AND SANITARY PROBLEMS. Lenzi, Giuseppe (CSN–CNEN, Casaccia, Italy). G. Fis. Sanit. Prot. Radiaz.; 13: 105-8(Jan-Mar 1969). (In Italian). (RT/PROT–(69)36).

The stratigraphy of the zone surrounding the Casaccia Nuclear Research Center of the CNEN is briefly described: the outcroping consist in various levels of quaternary tuffs and lavas lying on a pliocenic clayed and sandy series. The hydrologic investigations carried out in the surrounding little rivers are described and some probable conclusions about the possible contamination of the near springs and wells are deduced. On the basis of many distribution coefficients made by numerous volcanic tuffs samples of the zone, it was possible to point out that, from a general point of view, they are good exchangers for cesium; particularly the litoidic tuffs with black pumics (of ignimbritic type) that are rich in chabazite. This was confirmed by some investigations carried out in situ during a leak of radioactive liquids from an underground tank. (auth)

19087 CRYOGENICALLY COOLED RADIOACTIVITY BOREHOLE LOGGING TECHNIQUE. Dewan, John T. (to Schlumberger Tech. Corp.). U. S. Patent 3,496,360. 17 Feb 1970. Filed 22 Jun 1967.

A semiconductor radiation detector and the associated circuit in a borehole logging tool is illustrated. The tool is equipped with a liquefied gas-filled cryostat in which are immersed the detector and at least a portion of the detector signal preamplifier. A thermoelectric cooling module absorbs heat from the cryostat and discharges this heat through the tool housing to the borehole environment in order to stabilize the detector and preamplifier temperatures during long logging runs. (Offic. Gaz.)

19088 DISTRIBUTION OF RADIUM (^{226}Ra) IN HOT SPRINGS AND EVOLUTION MECHANISM OF STRONG RADIOACTIVE SPRINGS. Iwasaki, Iwaji (Tokyo Inst. of Tech.). Onsen Kogakkaishi; 7: No. 1, 16-24(Nov 1969). (In Japanese).

The Ra content of several hot springs in Japan was determined and compared with environmental chemical conditions. Even in the same precipitates from the same hot spring, the Ra content varied with precipitant location and more Ra was noticed in the precipitate deposited near the eruption point. It was found that the Ra content in hot springs does not correspond to that in the precipitate and no fixed relation between Ra content and the quantity of the precipitate was recognized. In order to examine the precipitation mechanism of Ra, some model experiments were carried out. The yield of Ra coprecipitated was high when $BaCO_3$ was used as a precipitant. When $Fe(OH)_3$ and $CaCO_3$ were precipitated together, the coprecipitation of Ra was more noticeable than when each substance was precipitated independently. Furthermore, the coprecipitation yield of Ra varied according to the evolution condition of $Fe(OH)_3$, and in the case of high pH, the yield is expected to go up to nearly 100%. When a relatively large amount of Ca^{2+} coexisted, the coprecipitation of Ra with $Fe(OH)_3$ was disturbed, and in this case the degree of disturbance was affected by the pH value. When 100 cc solution of pH 9 contained 0.00993g Fe in the coexistence of lg of the following ions, the disturbance decreased in the order of $Mg^{2+} > Ba^{2+} > Sr^{2+} > Ca^{2+} > K^{+} > Na^{+}$. (NSA of Japan)

19089 USE OF THE SIDEWALL NEUTRON LOG IN THE KEG RIVER FORMATION OF THE ZAMA AREA. Lishman, J. R. (Chevron Standard Ltd., Calgary, Alberta). 19p. of Second Formation Evaluation Symposium, Calgary, Alberta, May 1968. Calgary, Alberta; Canadian Well Logging Society (1968). (CONF-680559–1).

From 2nd Formation Evaluation Symposium, Calgary, Canada.

First use of the Sidewall Epithermal Neutron Porosity log suggests that it is an excellent porosity device for carbonate sections. It offers advantages over both the more established methods of logging porosity, i.e., acoustic velocity and gamma–gamma density logging. The Sidewall Neutron log appears to show very little difference in response between limestone and dolomite sections, so that no great error is induced by misidentifying the rock type. The Sidewall Epithermal Neutron Porosity log is useful in combination with other porosity devices (especially a density log) for determining mineralogy. Results have been checked against x-ray diffraction studies and thin section work. Some problems exist in present techniques for using a computer to calculate percentages of component minerals, but the full potential of the method has probably not yet been exploited. (auth)

19090 STUDY OF THE KINETICS OF RADIOGENIC GAS EMANATION BY ANNEALING OF URANIFEROUS MINERALS. Ashkinadze, G. Sh. (Inst. of Geology and Geochronology of the Precambrian, Leningrad). Geokhimiya; No. 1, 104-11(Jan 1970). (In Russian).

The kinetics of radiogenic xenon and helium emanation during the thermal annealing of a group of minerals of the phosphate and titano-tantalo-niobate group has been investigated. Minerals of the phosphate class are characterized by a high value of activation energy emanation of main xenon amounts (>120 kcal/mole). Metamictization of the initial crystalline structure leads the appearance of weakened structure sections from where the emanation of gases occurs at lesser activation energies. The investigated titano-tantalo-niobates are metamict (according to DTA data). Gas emanation during their annealing occurs in two stages. (auth)

19091 DETERMINATION OF THE NATURAL ISOTOPIC RATIO OF URANIUM BY MEANS OF A SCINTILLATION α-SPECTROMETER. Szy, Denes (Medical Univ., Budapest); Sebessy, Laszlo; Balint, Gyula; Szabo, Levente Atomtech. Tajec.; 12: 327-33(1969). (In Hungarian).

Determination of the $^{234}U/^{238}U$ ratio in sediments and fossils is of interest for the measurement of the age of geological formations. The new method for measuring the isotopic ratio of uranium by means of a scintillation α spectrometer involves four steps: determination of the uranium in natural waters; purification of the precipitate; electrolytic deposition, and finally measurement of the low activity source by the special scintillation α spectrometer. The α activity of the radiochemically pure natural uranium preparation is due mostly to ^{235}U and ^{238}U; the activity due to ^{234}U may be neglected; the β activity is due only to ^{238}U. The concentration of ^{234}U was also calculated by the usual method from the α and β activity measurements in comparison with a known reference standard. The new method avoids the otherwise necessary waiting period of about 180 days needed to allow the establishment of the equilibrium; it does not require the same absolute purity as the α-β method; in addition, it does not require the use of a reference specimen. (TTT)

Meteorology

Refer also to abstract 19309.

19092 (AD-698485) DEBRIS PREDICTION MODEL. Final Report. Edmunds, James E. (URS Research Co., Burlingame, Calif.). 30 Jun 1969. 26p. (URS-686-10). CFSTI.

Modifications to the debris prediction model with regard to the debris distribution procedures are described. Techniques were developed to more accurately predict debris depths in streets for light debris conditions. The reduction in the blast wave overpressure due to shielding effects within the built up city complex was also considered. (auth) (USGRDR)

19093 (AEC-tr-7122) RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT BY UNDERGROUND NUCLEAR EXPLOSIONS, AND METHODS OF FORECASTING IT, MOSCOW, 1969. Izrael, U. A.; Petrov, V. N.; Pressman, A. A.; Rovinsky, F. A.; Stukin, E. D.; Ter-Saakov, A. A. Translation of a Russian report. 65p. Dep. CFSTI.

The general pattern of an underground nuclear explosion, the zones of radioactive contamination, and the factors determining the contamination are discussed. The criteria of the radioactive cloud, the fallout pattern, the throwout in the crater area, and the secondary migration of the products are given. Certain data on Soviet underground nuclear explosion 1003 are given. Some methods of forecasting the contamination of an area are listed. (J.C.W.)

19094 (BARC-442) ENVIRONMENTAL CONCENTRATIONS OF SOME OF THE MAJOR INORGANIC POLLUTANTS AT THE BARC SITE, TROMBAY, BOMBAY. Zutshi, P. K.; Sequeira, R.; Mahadevan, T. N.; Banerjee, Tapoti (Bhabha Atomic Research Centre, Bombay (India)). 1969. 17p. Dep. CFSTI (U. S. Sales Only).

Aggregate monthly averages of some of the major inorganic pollutants in the atmosphere, at the BARC site at Trombay, Bombay over the past few years are presented. In an attempt to broadly assess the extent of air pollution at the sampling site the results are compared with known international air quality standards. (auth)

19095 (BNL-50206) THE ATMOSPHERIC DIAGNOSTICS PROGRAM AT BROOKHAVEN NATIONAL LABORATORY: SECOND STATUS REPORT. Tucker, Walter D. (ed.) (Brookhaven National Lab., Upton, N. Y.). Nov 1969. 42p. Dep. CFSTI.

The Isotope Ratio Tracer Method provides a means of unambiguously tracing sulfur in the atmosphere. It is specific, and the tracer behaves exactly like pollutant sulfur, since it makes use of sulfur already in a fuel. It is a nonradioactive method and is applicable to a wide range of problems. Each of the elements necessary for its implementation has been developed and is in routine operation. This includes means of efficiently collecting samples that are adequate in size and representative of both SO_2 and SO_3 from furnace systems and SO_3 and sulfates from the air at ground level and aloft, methods and apparatus for quantitatively processing small samples in preparation for isotope mass measurements, and design, procurement, and operation of an isotope ratio mass spectrometer with high sensitivity. Techniques for using SF_6 as a collateral tracer have also been developed. The IRT method can be applied both to problems in the physical tracing of sulfur, such as in stack plumes, and to studies of the chemistry of sulfur oxides in the atmosphere. Results are reported on investigations currently under way, including combustion studies in power plants, plume dispersion from tall stacks, and pollution patterns in the small city. (auth)

19096 HUNTING HOT SPOTS IN UTAH. Nucl. News; 13: No. 2, 20-1 (Feb 1970).

A comprehensive program, undertaken in Utah to detect radioactive fallout in the environment and to determine its potential effects on people, livestock, and wildlife is described. The personnel, funding, sampling methods, types of samples to be collected, monitoring apparatus and locations are discussed. (L.C.L.)

19097 SURVEILLANCE OF PREVENTION FROM CONTAMINATION OF RADIOACTIVITY. Suzuki, Masashi (National Inst. of Radiological Sciences, Chiba, Japan). Koshu Eisei; 33: 446-53 (Aug 1969). (In Japanese).

The environmental investigation of radioactivity in Japan started after the occurrence of the ash event of Fukuryu-maru No. 5. After the establishment of the National Institute of Radiological Science as well as the international UNSCEAR, investigations of radioactive fallout were started. At present, at almost one hundred sampling points all over the country, samples of dusts at high altitudes, foods and human bones, etc., are collected, measured, and analyzed. These investigations, especially on fallout due to nuclear experiments, have been classified into general, special, and temporary investigations; and geographically into the whole country and to local investigations. The radioactivity investigations in Japan have been acknowledged to be rather large in scale. The results of these investigations have been reported in detail in "Radioactivity Survey Data in Japan" published by the Radioactivity Survey Data Center of the National Institute of Radiological Science. For the future, the surveillances of not only the fallout due to nuclear experiments, but of radioactive contamination caused by peaceful utilization of atomic energy have to be considered as well as the bodily effects and the hereditary influences. (NSA of Japan)

19098 KINETICS OF THE UNIPOLAR CHARGE ACQUISITION BY β-ACTIVE "HOT" PARTICLES IN AN ELECTRIC FIELD. Kirichenko, V. N.; Ivanov, V. D. Dokl. Akad. Nauk SSSR; 188: 315-17 (11 Sep 1969). (In Russian).

Following up earlier studies on the appearance of an electron-emission-induced unipolar charge on highly radioactive aerosols, the kinetics of such charges of β-active "hot" aerosol particles in the external electric field was examined. The behavior of these particles in electric precipitators and in the electric fields of terrestrial or industrial atmosphere is of great importance. The experimental study of the kinetics of the particles was carried out in a 17-cm wide and 300-cm high column with an acetone suspension of from 1 to 6-μ diameter glass and resin particles; the individual activity of the particles ranged from 10^{-10} to 10^{-9} Ci. The additional charge was applied by a plane-parallel condenser. The experimental data agreed with the theoretical formula describing the charge kinetics of β-active hot particles in an external field. (TTT)

Mineralogy and Exploration

Refer also to abstract 19085.

19099 DOBYCHA POLEZNYKH ISKOPAEMYKH PODZEMNYM VYSHCHELACHIVANIEM. RAZRABOTKA RUDNYKH MESTOROZHDENII FIZIKO-KHIMICHESKIMI I MIKROBIOLOGICHESKIMI METODAMI. (Ore Extraction by Underground Leaching. Development of Ore Deposits by Physicochemical and Microbiology Methods). Kalabin, A. I. Moscow; Atomizdat (1969). 376p.

The theory of filtration leaching of ores and practical applications of underground leaching of various minerals (potassium salts, copper, gold, uranium, iron, sulfur) and metal leaching by various bacterial solvents are discussed. The technology, methods, and various geological and hydrological criteria used in leaching operations are described. The economic aspects of leaching operations for various ores are evaluated. 375 references. (R.V.J.)

19100 GEOLOGY OF THE RUM JUNGLE URANIUM DEPOSITS. Berkman, D. A. At. Energy Aust.; 13: 12-22 (Jan 1970).

An abstract of this article, prepared from the published conference proceedings, appeared as NSA 23: 40894.

19101 A COMPARATIVE EVALUATION OF SCINTILLOMETRIC, GEOCHEMICAL, AND BIOGEOCHEMICAL METHODS OF PROSPECTING FOR URANIUM. Bowie, S. H. U.; Ostle, D. (Inst. of Geological Sciences, London). Econ. Geol.; 64: 933 (Dec 1969).

A brief discussion is presented on experience with various methods of uranium prospecting. Both aero-radiometric surveying and hydrogeochemical (the analysis of steam waters) prospecting were used successfully. The use of neutron activation analysis to accurately determine the uranium content of solids or fluids is recommended. (L.C.L.)

19102 A COMPARATIVE EVALUATION OF SCINTILLOMETRIC, GEOCHEMICAL, AND BIOGEOCHEMICAL METHODS OF PROSPECTING FOR URANIUM: A REPLY. Brooks, R. R.; Whitehead, N. E. (Massey Univ., Palmerston North, N. Z.). Econ. Geol.; 64: 933-4(Dec 1969).

The advantages and limitations of aero-radiometric and hydrogeochemical methods for uranium prospecting and the use of gamma spectrometry for soil analysis are briefly discussed. (L.C.L.)

19103 URANIUM DEPOSITS IN THE LOWER CRETACEOUS OF THE BLACK HILLS. Renfro, A. R. (Teton Exploration Drilling Co., Inc., Casper, Wyo.). Contrib. Geol.; 8: 87-92 (Summer 1969).

Geology of the U host sediments in the Black Hills of North Dakota and Wyoming is discussed. This region has produced ~4 million lb of U_3O_8. All of the known U ore bodies are in continental and marginal marine sandstone of the Lower Cretaceous, Inyan Kara Group. The Inyan Kara Group is comprised of the Lakota and overlying Fall River Formations which represent the proximal and distal portions of a single, transgressive U depositional system. The regional depositional environments that affected each formation indirectly affected the geometric complexity and extent of related U deposits. Uranium deposits of the Inyan Kara Group are of the roll front type. They were deposited by down-plunge migrating geochemical cells which were initiated during the Laramide orogeny. Passage of geochemical cells through the host rocks caused physical and chemical changes that provide excellent exploration guides. These changes include oxidation of massive, pore filling pyrite, destruction of disseminated carbon, and leaching of indigenous U. The source of U in the Inyan Kara roll fronts is considered to be the altered host sandstone, as indicated by relative lack of U in altered ground as opposed to relative abundance of U in fresh ground. Extensive low grade U reserves are indicated or inferred in the northern Black Hills. Typical deposits contain approximately 250,000 lb of U_3O_8 per mile of roll front. Individual roll fronts can be traced for tens of miles though they do not everywhere contain ore grade mineralization. Similar roll fronts are anticipated to extend, with interruption, around the Black Hills. Such deposits ultimately will be the main source of U in the Black Hills. (BBB)

19104 URANIUM DEPOSITS OF THE GAS HILLS. Anderson, Don C. (Utah Construction and Mining Co., Riverton, Wyo.). Contrib. Geol.; 8: 93-103(Summer 1969).

The Gas Hills Uranium District, located in central Wyoming along the southeastern margin of the Wind River Basin, has produced about 12% of the U in the United States. The source beds for the U deposits are arkosic sandstones interstratified with lensing mudstones and shales. Two distinct types of sandstone are present in the Wind River Formation. The youngest is yellowish-orange to yellowish-gray arkose, derived primarily from Precambrian gneissoid and granitoid rocks; it contains little clay, abundant calcium carbonates, and limonite cement, and is hot for all U deposits of the district. Of the 4 types of U deposits found in the district, the most important are the solution-front deposits. They were formed along the margins of highly altered, tabular sand beds that are enclosed by overlying and underlying fine-grained siltstone, claystone, and carbonaceous mudstone beds. The solution fronts are ideally crescentic or "C" shaped when viewed in cross section, with thin mineralization forming the tips of the crescents. The U minerals occur as earthy brown to black coating on the interstitial fillings between the quartz sand grains. The primary U ore minerals are coffinite and uraninite. The 3 other types of deposits include transitional bedded, oxidized, and residual remnant deposits. The oxidized and residual remnant deposits are usually small and difficult to mine. Ground waters trapped by the southward tilting of the Tertiary rocks during late Miocene time became stagnated. These waters dissolved U from the enclosing rocks, and after erosion had exposed the highest beds of the Wind River Formation, the mineral-rich solutions gained egress, from the enclosing sand aquifers, toward the north and the solution-front U ore deposits began to form. (BBB)

19105 STRATIGRAPHIC CONTROL OF SANDSTONE URANIUM DEPOSITS IN WYOMING. Webb, M. Dean (Kerr-McGee Corp., Oklahoma City). Contrib. Geol.; 8: 121-9(Summer 1969).

After a discussion of stratigraphic control of U ore deposits in Wyoming basins, it is postulated that the fundamental position of U accretion is primarily related to facies controlled geochemically favorable environments. The sedimentation and development of the favorable facies are described as to origin within the conceptual model. The development of a U deposit within the model is discussed within the context of geology, chemistry, and microbiology. Sediments were largely derived from granitic and metamorphic terrains adjacent to the basins of deposition. The U was derived from the source terrain and after mobilization was deposited and redistributed by connate, phreatic, and vadose waters. Uranium concentration was initiated during the period of compaction by direct absorption in humic components and by a system of microorganisms living on the carbonaceous substrate. Later Tertiary uplift introduced extensive oxidation into the system creating major modification and reaccretion of U in the same geochemically favorable carbonaceous environment. These late oxidation phases are postulated to have been responsible for most of the economically exploitable deposits. In the uplift and oxidation cycles the physiological activities of at least 2 genera of microorganisms played a significant role in both the mobilization and in the accretion of U. (BBB)

19106 URANIUM DEPOSITS IN SHIRLEY BASIN, WYOMING. Melin, Robert E. (American National Bank Bldg., Denver). Contrib. Geol.; 8: 143-9(Summer 1969).

Uranium deposits in Shirley Basin occur in arkosic sandstone beds of the Eocene Wind River Formation. The Wind River ranges from a wedge-out to about 500 ft thick and consists of light gray fine-grained to conglomeratic sands mostly less than 100 ft thick interlayered with green clay-silt beds. In the mines area the beds dip about 1° north-northeast. Uranium deposits consist of disseminations and impregnations of uraninite, calcite, pyrite, and marcasite in arkosic sands. Much of the U is in crescentic rolls, but important amounts are in tabular bodies near the rolls. The larger ore bodies in the mines area are distributed along the down-dip and lateral periphery of tongues of altered ground. Obvious alteration effects include a color change from pale gray to light tan or yellowish-gray, and removal of pyrite, calcite, and carbonaceous material. The deposits apparently were formed by migrating reactive ground water solutions that collected U from the ground it altered, moved U downstream, and concentrated it in emplacements at interfaces between altered ground and unaltered ground. (auth) (BBB)

19107 ASPECTS OF THE GEOLOGIC HISTORY OF WYOMING RELATED TO THE FORMATION OF URANIUM DEPOSITS. Houston, Robert S. (Univ. of Wyoming, Laramie). Contrib. Geol.; 8: 67-79(Summer 1969).

Uranium has been found in virtually every major time rock unit known in Wyoming from rocks of Precambrian age to rocks of Pleistocene age. The most important deposits economically, however, are in various formations of early Eocene age and therefore aspects of the geologic history of Wyoming related to the formation and subsequent history of these units are emphasized. The Precambrian rocks of most significance to U genesis are the granites of Early Precambrian age. One theory holds that these granites are the main source of the U in the early Tertiary host rocks, either as U leached from granite during weathering or as U leached from arkose derived from the granite. A variety of sources has been suggested for the U, a number of different solutions as transporting mediums, and even different mechanisms for deposition. In the discussion presented, the U deposits are examined from purely a historical view and alternatives considered for their formation. It would appear that acidic groundwater that may have characterized the Eocene source areas could have easily leached any U available in the granites, and perhaps from more soluble minerals of the arkose. This U must have been transported in groundwater of unknown character but perhaps of lower pH than that of today. The U may have been precipitated in areas of concentrated organic debris by reduction. Various other possibilities that probably exist for the source, transportation mechanism, and method of deposition of U in the formations of early Eocene age in Wyoming are also considered. (BBB)

19108 URANIUM DEPOSITS OF THE POWDER RIVER BASIN. Davis, James F. (Union Pacific Railroad Co., Laramie, Wyo.). Contrib. Geol.; 8: 131-41(Summer 1969).

Uranium in the Powder River Basin is in the form of geochemical roll fronts associated with a decrease in permeability in arkosic sandstones of the Wasatch Formation and to a limited extent, the Fort Union Formation. Previously mined deposits were for the most part oxidized. Many recent discoveries are more extensive unoxidized ore bodies. The host sands are correlated over several miles. The origin of the U is postulated to be the Oligocene, Miocene, and Pliocene tuffs which once covered the area. Hydrolysis of the tuffs produced an alkaline ground water which dissolved the U and carried it as a U tricarbonate ion. The solutions were carried by coarse, regionally transmissive sand units which were stained pinkish-red by hematite, formed from oxidation of pyrite by oxygen in the solutions. Cores of unaltered Wasatch arkosic sand contain less than 2 ppM U, whereas cores from well back in the altered rock contain 18 ppM U. The ore deposits are usually multiple C-shaped rolls distorted by varia-

tions in the gross lithology. The individual rolls range in thickness from 2 to 20 ft and may be several thousand feet in length. Low-grade (0.05 to 0.10% U_3O_8) protore, up to 40 ft thick and several hundred feet wide, is commonly present on the unaltered side of the higher-grade roll front. In the unoxidized ore deposits studied, the U/eU ratio is almost universally high. (BBB)

19109 GROUND WATER AS RELATED TO THE ORIGIN AND SEARCH FOR URANIUM DEPOSITS IN SANDSTONE. Butler, Arthur P. Jr. (Geological Survey, Denver). Contrib. Geol.; 8: 81-6(Summer 1969).

Data on the composition of water from points close to the U deposits or from within the area where they occur are summarized, the general aspects of ground water movement are reviewed, and some aspects of ground water composition bearing on the utility of ground water in prospecting for U are mentioned. Slightly alkaline bicarbonate sulfate ground water generally similar to the modern ground water probably was the agent that formed the U deposits in fluviatile sandstone in Wyoming. Such water could transport U at low temperatures and from it U could be precipitated. Lack of evidence for any conduits in underlying rocks and the absence of igneous rocks near deposits in some areas suggest that U deposits were not formed by juvenile thermal water. The large volume of mildly oxidized rock to which the U deposits are marginal suggests that oxygen-poor connate water was not the agent that formed the U deposits. Modern ground water moves downward from higher to lower elevations in the same general direction as associated surface drainage; the ancient water which formed the U deposits undoubtedly moved in a similar way with respect to the paleodrainage. In addition to being the agent for emplacement of U deposits, ground water may be a guide to general areas in which deposits occur, although its utility as a guide to unoxidized U deposits below the water table is not clearly established. Sulfate is of doubtful utility as a guide in exploration, and the U content of ground water is an imperfect general guide. (BBB)

19110 URANIUM DEPOSITS IN THE GREAT DIVIDE BASIN–CROOKS GAP AREA, FREMONT AND SWEETWATER COUNTIES, WYOMING. Bailey, Robert V. Contrib. Geol.; 8: 105-20 (Summer 1969).

In the Great Divide Basin-Crooks Gap area, in south-central Wyoming, U mineralization has been found in 3 types of deposits: (1) low-grade deposits associated with Eocene sub-bituminous coal and carbonaceous shale in the central and eastern part; (2) low grade caliche-type deposits of schroeckingerite in Eocene sediments in the north-central part; and (3) higher grade deposits, some of which are minable, in Eocene sandstone and conglomerate at Crooks Gap at the north edge of the basin. There are an estimated 60 million lb or more of U_3O_8 associated with minable coal in the Great Divide Basin, and additional unestimated quantities in carbonaceous shales. The schroeckingerite deposits are believed to be small, and the mineral is water soluble. Production and minable reserves at Crooks Gap are estimated at between 11 and 12 million lb U_3O_8. Uranium associated with the coal was evidently derived from overlying Miocene sediments. A similar theory is postulated for the origin of U found in the schroeckingerite deposits. It is suggested here that the U in the Battle Spring Formation at Crooks Gap also originated in younger volcanic-rich sediments, and that the U, subsequently to its release from the tuffaceous rocks, migrated in neutral to slightly alkaline, weakly oxidizing ground water into the highly permeable Battle Spring Formation where Eh and pH changes resulted in U concentration in zones along geochemical interfaces. (BBB)

Oceanography

19111 ^{222}Rn IN ANTARCTIC NEAR-SURFACE WATERS. Mathieu, Guy G. (Columbia Univ., New York). Antarctic J. U. S.; 4: 185-6(Sep-Oct 1969).

Radium-226 in the ocean decays into ^{222}Rn, which then partly escapes to the atmosphere, resulting in a deficiency in ^{222}Rn in near-surface waters. Hence, by measuring both ^{222}Rn on board ship and ^{226}Ra later on in the laboratory, it is possible to determine the ^{222}Rn deficiency. As this deficiency in turn depends on the rate of near-surface vertical mixing and the rate of gas exchange between the water and the atmosphere, these measurements provide rates of mixing and exchange. After shipboard sampling of the water at depths of 50, 100, 200, and 400 m, the ^{222}Rn was then extracted and counted in an α scintillation counter. All 18 profiles measured show an increase in ^{222}Rn with depth. The surface samples vary from 33 to 76% of the deeper values, the average being 60%. A general increase in ^{222}Rn in near-surface waters with increasing latitude was discovered, probably reflecting an increase in ^{226}Ra concentration related to upwelling of deep Pacific and Indian water in the Antarctic. (BBB)

19112 ^{228}Ra IN HIGH-LATITUDE SOUTHERN HEMISPHERE WATERS. Kaufman, Aaron (Columbia Univ., New York). Antarctic J. U. S.; 4: 187(Sep-Oct 1969).

Preliminary data indicate that there is a sharp drop-off in the $^{228}Ra/^{226}Ra$ ratio of surface Indian Ocean waters approaching Antarctica. A probable explanation for this decrease is that the Ra, introduced in the more northerly regions, has been in contact with continental materials more recently. Hence, ^{228}Ra, with its 6.7-yr half-life has had only a relatively short time to decay. Going farther south, a larger component of the surface water is derived from deep water. The ^{228}Ra of the deep water, which has been removed from continental material for a longer period of time, has decayed almost completely. Surface seawater samples were collected on Cruises 35 and 37 of Eltanin along 4 north-south traverses. These analyses show the rates at which deep water mixes with surface water in the Australia-New Zealand area of the antarctic seas. (BBB)

19113 RADIOISOTOPES. Noshkin, V. Oceanus; 15: 13 (May 1969).

A brief description is given of oceanographic investigations of the changing distribution of radioisotopes present in the marine environment as a result of nuclear testing in the ocean and atmosphere. Three large volume sampler stations were employed, down to a depth of 4100 m, along with ordinary hydrographic data (Nansen bottles) to determine the concentration of specific radioisotopes in the Sargasso water masses. The results showed how rapidly various radioelements move from the sea surface towards the bottom sediment. By relating these data to other factors (such as how the isotopes move through the cycle of marine life) the mechanisms responsible for the movements of the chemical elements can be elucidated. The water collected was of particular interest in that the first of the stations was made south of the subtropical convergence zone and the other two stations north of this boundary. The second station was located just north of the convergence as determined by bathythermograph and surface temperature observations. This convergence zone is an important boundary zone for fish, plankton, and birds. Whether there is also a discontinuity in radioactive fallout concentration will be determined. The determination of ^{14}C, tritium, and stable rare earth element concentrations are also being measured. (BBB)

19114 RADIUM AND INORGANIC CARBON IN ANTARCTIC WATERS. Teh-Lung-Ku (Woods Hole Oceanographic Institution, Mass.); Li, Yuan-hui; Mathieu, Guy G. Antarctic J. U. S.; 4: 186-7(Sep-Oct 1969).

Simultaneous analyses were made of ^{226}Ra, P_{CO_2}, ΣCO_2, and U isotopes in profiles taken during cruises along a meridonal trend (between 125°E, and 145°E) extending from the antarctic continental shelf to the South Australian Basin. These measurements showed that the Antarctic Convergence (located around 52°S to 55°S in the area studied) forms a boundary for the distribution of Ra. South of the Convergence, the Ra profiles were uniform, concentrations near the surface being close to 8×10^{-14} g/l and those of the deep waters 10×10^{-14} g/l. North of the boundary, surface concentrations dropped, whereas bottom values remain near 10×10^{-14} g/l. Evidently the advection effect on the distribution of Ra is strongly emphasized in this part of the ocean. A biologically controlled process for the Ra distribution cannot be dismissed. There appeared to be no significant difference in the Ra distribution across the Subtropical Convergence. Uranium concentrations ranged between 2.98 and 3.32 μg/l. When normalized to salinity, virtually no variations have been detected within the experimental error range of ± 2%. The $^{234}U/^{238}U$ activity ratios were 1.14 ± 0.02. These results did not differ from measurements in other parts of the ocean. The U-series radioactive disequilibrium relation in the Antarctic waters were, in terms of activity ratios, $^{234}U/^{238}U = 1.14$ $^{226}Ra/^{238}U < 0.1$, $^{226}Ra/^{230}Th > 100$. (BBB)

19115 NATURAL RADIOCARBON IN THE MEDITERRANEAN SEA. Broecker, Wallace S.; Gerard, Robert (Columbia Univ., Palisades, N. Y.). Contract AT(30-1)2663. Limnol. Oceanogr.; 14: 883-8(Nov 1969).

Carbon-14/carbon-12 ratios for inorganic carbon extracted from 11 water samples collected in the Mediterranean Sea during the summers of 1956 and 1958 fall within the range of 0.917 to 0.952 of the fractionation corrected $^{14}C:^{12}C$ ratio for pre-1900 atmospheric CO_2. This small range indicates that vertical mixing takes place within this sea on a time scale of about 100 years. The $^{14}C:^{12}C$ ratios in the surface and intermediate waters of the Mediterranean are, as expected from hydrologic considerations, nearly equal to those in the adjacent surface North Atlantic. (auth)

19116 SOME RADIOACTIVITY MEASUREMENTS OF SEDIMENT SAMPLES COLLECTED IN THE NORTH ADRIATIC SEA. Cerrai, E. (CISE, Milan); Mezzadri, M. G.; Schreiber, B.; Triulzi, C. Energ. Nucl. (Milan); 17: 176-81(Mar 1970).

Some sediment samples, collected in the Adriatic Sea on January 15, 1966 during the N/O Bannock cruise were analyzed to determine the content of ^{90}Sr, ^{226}Ra, ^{137}Cs, ^{144}Ce, ^{147}Pm, ^{155}Eu, ^{60}Co, and ^{125}Sb. Samples consisted of 1-cm and 5-cm thick upper layers of sediment. Results indicate that more radioactivity is contained in the fine fraction of sediment samples collected North of 45° parallel. Besides, a comparison is reported between these radioactivity data and those concerning coastal sediment samples of the Ligurian Sea. (auth)

19117 THE GEOCHEMICAL BALANCE OF RADIOACTIVE ELEMENTS IN THE BASIN OF THE BLACK AND AZOV SEAS. II. RESERVES OF THORIUM ISOTOPES. Nikolaev, D. S.; Drozhzhin, V. M.; Lazarev, K. F.; Korn, O. P. Radiokhimiya; 11: 688-98(1969). (In Russian).

The concentrations of thorium and ionium (thorium-230) were determined in the water and suspensions of the main rivers in the basin of the Black and Azov Seas. On the basis of the data obtained, the main elements of balance and the reserves of thorium and ionium in the Black and Azov Seas were determined. The amounts precipitated in deep and shallow water zones in the Black Sea annually are 143 and 691 tons of thorium and 19100 and 10400 g of ionium. It was calculated that the residence time of thorium in the aqueous phase is 56.5 years for the Black Sea and 160 days in the Azov Sea; for ionium the values are 365 years and 172 days, respectively. (tr-auth)

Seismology

19118 (CGS-746-101) MILROW SEISMIC EFFECTS: PRELIMINARY REPORT. Engdahl, Eric R. (Coast and Geodetic Survey, Rockville, Md.). [nd]. 21p. Dep. CFSTI.

The historical earthquake record has been examined in detail, relative to nuclear testing on Amchitka Island. The record indicates that the Aleutian Arc is an area of high seismic activity. Furthermore, this earthquake activity is highly variable in rate of occurrence and spatial distribution. Recent evidence indicates large earthquakes and tsunamis may originate along a major thrust fault which passes under the Aleutian Ridge. On the basis of all available data, however, no large earthquakes are believed to have occurred along this fault directly under Amchitka Island. To determine the natural earthquake patterns, and the possibly adverse effects of nuclear detonations in the Aleutian Islands, particularly in the Amchitka Island region, the AEC established last spring a network of highly sensitive seismic stations to monitor continuously the seismic activity. This network has significantly improved the capability to detect and locate earthquakes in the region. Following Milrow, data obtained from this network were compared with the historical record and pre-Milrow monitoring. Except in the immediate vicinity of ground zero, there was no evidence for a temporal or spatial change in the pattern of natural earthquake occurrence in the Aleutian Islands. The exception was a swarm of hundreds of very small earthquakes, occurring immediately after detonation in a zone not more than 3 miles in radius from ground zero. This activity terminated abruptly 37 hours later at the time of the Milrow cavity collapse. The largest of these earthquakes were more than 100 times smaller than the explosion, in terms of energy release. The occurrence of these small seismic events is not unusual and has been noted following nuclear tests in Nevada. Many of the events are believed to be adjustments within the cavity region. Since they are very small, of short duration, and occur in the immediate vicinity of the explosion, they do not constitute a hazard to the major fault zone under Amchitka Island. (auth)

19119 RESIDUAL STRAINS ASSOCIATED WITH A NUCLEAR EXPOLOSION. Romig, P. R.; Major, M. W.; Wideman, C. J.; Tocher, Don. Mines Mag.; 59: No. 6, 4-7(1969).

Two quartz-bar strainmeters were entrenched north of Beatty, Nevada, to observe the Benham underground nuclear test of December 19, 1968 (M = 6.3). These instruments, oriented approximately radially to the source, were located at distances of 28 km and 71 km from ground zero. Step-like residual strains of 1.8×10^{-7} and 0.35×10^{-7}, respectively, were recorded. These results agree with those reported for earthquakes of M = 6.2. They also tend to substantiate the decay with distance law of $R^{-1.5}$ observed for earthquakes as opposed to the theoretical R^{-3}. It was observed that while earthquake steps do not decay within several days if at all, the strain step from Benham apparently decayed to near zero within half an hour. This decay with time appears to be a reflection of the pressure history of the cavity. (Geophys. Abstr.)

19120 RECORDING NUCLEAR BLAST. Mines Mag.; 58: No. 6, 8-9(1968).

On April 26, 1968, at 8 a.m. MST, the AEC detonated a nuclear explosion at the National Test Site in Nevada roughly equivalent to an earthquake of magnitude 6.25. Photographs and records made between 8 and 8:15 a.m. at the Colorado School of Mines Geophysics Department are shown. (Geophys. Abstr.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 19053, 19084, 19092, 19093, 19097, 19118–19120, 19262, and 19917.

19121 (PNE–526) ECOLOGICAL AND ENVIRONMENTAL EFFECTS FROM LOCAL FALLOUT FROM SCHOONER. 1. SOIL THERMOLUMINESCENCE IN RELATION TO RADIATION EXPOSURE UNDER FIELD CONDITIONS. Project SCHOONER; Project CEP-68.5. Nishita, Hideo; Rhoads, William A. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology. EG and G, Inc., Goleta, Calif.). 27 Feb 1970. Contracts AT(29-1)-1183; AT-04-1-GEN-12. 21p. Dep. CFSTI.

A study was conducted to determine whether or not soil thermoluminescence could be related to radiation exposure in the field under conditions of actual nuclear detonation. The correlation coefficients between TLD-100 LiF dosimeter determinations and soil thermoluminescence for noncalcareous and slightly calcareous soils were 0.93 and 0.89, respectively. These results suggest that soils might be used to estimate the radiation exposure received by a given area. With a highly calcareous soil studied, the correlation coefficient (0.78) was poorer, indicating the lower suitability of this type of soil. Since soils exhibit variable amounts of "natural" thermoluminescence, pre-irradiation soil sample collection appeared to be necessary. This preirradiation sample might then be used to determine the amount of "natural" thermoluminescence and the "equivalent" exposure level by irradiating it with a known radiation source. The applicability of these procedures, however, remains to be tested. (auth)

19122 (UCRL–50390(Rev.1)) BUGGY PRESHOT ANALYSIS. Lessler, R. M.; Tewes, H. A.; Toman, John (California Univ., Livermore. Lawrence Radiation Lab.). Feb 1968. 54p. Dep. CFSTI.

The preshot studies for Project Gasbuggy, the first nuclear row-cratering experiment, are discussed. Descriptions are given of the site and charge characteristics, emplacement plans, and the predicted results on air blast effects, crater dimensions, explosion cloud formation, and fallout transport and deposition. (L.C.L.)

19123 DISCUSSION PAPER: INTERSTELLAR TRANSPORT. Dyson, Freeman J. (Inst. for Advanced Study, Princeton, N. J.). Ann. N. Y. Acad. Sci.; 163: 347-57(4 Sep 1969).

The Orion Project for nuclear-powered space vehicles is discussed and relative advantages of chemical and nuclear propulsion are considered. Chemically propelled vehicles are inefficient for journeys to the moon, and are impractical for making round trips to the planets, because of their staging problem. The basic advantage of an Orion vehicle is that it has only one stage, with a mass ratio well under 10 for long trips around the solar system. It can be built small and rugged, and comparatively cheaply. It avoids big mass ratios because the effective exhaust velocity of the debris from a nuclear explosion is hundreds or thousands of Km/sec instead of the 3 Km/sec debris velocity of a chemical rocket. The upper limit to debris velocity lies somewhere in the range 3000 to 30,000 Km/sec, that is, between 1% and 10% of the velocity of light. The relation of debris velocity to exhaust velocity would depend on the design of the vehicle. The problems of radiation damage and shielding for machinery and crew would decrease exponentially with the mass available for shielding. Missions in the 10,000 Km/sec class would cost about 10^{11} dollars for a payload of 10^4 tons. Because 10,000 Km/sec is 1 parsec per century, these missions could reach many nearby stars in the course of a few centuries. (BBB)

Facilities and Equipment

Refer also to abstracts 19150, 19183, 19455, and 19852.

19124 (DUN–5935) CELL NO. 1 ISOLATION FOR STEAM GENERATORS 1A AND 1B DECONTAMINATION AND RETUBING, AND VALVE CHECK LISTS. Tausch, E. T. (Douglas United Nuclear, Inc., Richland, Wash.). 18 Jun 1969. 29p. Dep. CFSTI.

The procedure used at Douglas United Nuclear, Richland, Washington, to isolate cell No. 1 piping from the remainder of the operating piping systems is described. This isolation is necessary to minimize interference with the operation of the remainder of the plant, to minimize the hazards of high temperature, high pressure, and contaminated fluids to personnel in the cell during reactor operation, and to prepare the cell for steam generator decontamination and retubing work. Three piping modifications were made to provide the capability for decontaminating the cell during plant operation. Piping schematics, step-by-step operating instructions, and operations check lists are included. (L.C.L.)

19125 (DUN–6075) SPECIAL OPERATING PROCEDURE: CELL 1 DECONTAMINATION. Junghans, C. A.; Clausing, J. C. (Douglas United Nuclear, Inc., Richland, Wash.). 29 Jul 1969. 26p. Dep. CFSTI.

The procedures used for steam generator decontamination at Douglas United Nuclear, Richland, Washington is described in detail with piping schematics, descriptions of the pipe, pump, and valve equipment required, step-by-step operating instructions, and operations check lists. (L.C.L.)

19126 (NP–18146) EXPERIMENTAL LOOP: SKODA. Martinek, Jan; Novotny, Karel ([Skoda Concern,] Pilsen (Czechoslovakia). Nuclear Power Plants Div.). [nd]. 16p. Dep. CFSTI (U. S. Sales Only).

An experimental loop of the Nuclear Power Plant Division of SKODA Concern is described. The facility is presently assigned to research and testing of the gas-cooled nuclear reactor components under operational parameters, and to conduct research and tests of the fuel elements, control mechanisms and elements, pressure tube channels, and other components of the primary circuits of the nuclear power plant. The unit may be converted for testing components of the advanced gas-cooled converter and gas-cooled fast reactors. The working medium of the loop is CO_2. Engineering drawings are included. (J.C.W.)

19127 (UCRL–50779) NONLINEAR DYNAMICS OF SOLIDS BY FINITE ELEMENT METHODS. Hartzman, Mark (California Univ., Livermore. Lawrence Radiation Lab.). 19 Dec 1969. 101p. Dep. CFSTI.

Thesis.

A method for analyzing the nonlinear dynamic response of deformable solids, subjected to time and space dependent thermal and mechanical loads, is developed. The nonlinearities considered in this analysis are due to the nonlinear character of the strain displacement relations and the equations of motion, and to the nonlinear constitutive relations which describe the physical behavior of the material. In this investigation, elastic-plastic relations of the incremental (Prandtl-Reuss) type were chosen for material description. A displacement-type finite element method is applied to reduce the governing partial differential equations to a set of simultaneous nonlinear ordinary differential equations of motion of a lumped mass system connected by three-dimensional elements. These equations are solved by applying a step-by-step numerical technique in conjunction with the constitutive relations. The analysis is applied to two plane wave propagation problems and two large deformation problems of shells and beam under blast loading. Comparison of analytical or experimental results with numerical calculations indicates good agreement. (auth)

19128 VERY HIGH TEMPERATURE IRRADIATION FURNACES. Briand, A. (CEN, Grenoble, France). Rev. Int. Hautes Temp. Refract.; 6: 137-47(Jul-Sep 1969). (In French).

Irradiation temperatures up to 2,000°C can be controlled in the core of nuclear reactors Siloe (3C MW) and Melusine (4 MW) with induction furnaces designed for this purpose. The engineering specifications of sample holders for the design of new experiments are given. (auth)

19129 NEW DEVICE FOR MELTING WITHOUT CRUCIBLE. FUSION OF HIGH MELTING OXIDES IN A MULTITUBULAR SYSTEM. Roulin, Yves; Vitter, Gerard; Deportes, Charles (Faculte des Sciences, Grenoble, France). Rev. Int. Hautes Temp. Refract.; 6: 153-7(Jul-Sep 1969). (In French).

Technical improvement of the melting method without crucible is given. The apparatus is made of a parallel tube system, cooled by water circulation. The same device allows the stable fusion of oxides—or mixtures of oxides—having very different conductibility. The advantages of this method are discussed. (auth)

19130 EXECUTION AND DEVELOPMENT OF HEAT EXCHANGERS IN NUCLEAR POWER PLANTS AND EXPERIMENTAL FACILITIES. Stuermer, H. (L. and C. Steinmueller GmbH, Gummersbach, Ger.). Kerntechnik; 12: 9-16(Jan 1970). (In German and English).

The heat exchangers used in nuclear engineering are very similar in respect of structural components and of the calculation data to those already proven in chemical engineering. The main differences are due to the more stringent safety require-

ments stipulated in nuclear engineering. Heat exchangers and their particular features are described in which no change of the aggregation state of the flowing media takes place. (auth)

19131 FLUID-FLOW CONTROL VALVE. Le Bot, Camille; De Montpreville, Christian Thomas (to Commissariat a l'Energie Atomique). British Patent 1,183,760. 11 Mar 1970. Priority date 25 Jan 1967, France.

The design is given of a fluid flow control valve, which is suitable for mounting in equipment to be used in channels of a nuclear reactor during irradiation. The valve is gas-tight to helium when temperatures are above 400°C and during nuclear radiation. (J.C.W.)

19132 BALL-CRUSHER. Andre, Roger; Fradin, Jean; Rouet, Michel (to Commissariat a l'Energie Atomique). British Patent 1,183,902. 11 Mar 1970. Priority date 23 Jan 1967, France.

A design is given of a ball-crusher suitable for processing materials having properties which make it necessary to keep them in an enclosure separated from the atmosphere and when the resultant products are radioactive or poisonous dusts. The design permits remote control transfer of the material to be crushed easily between the crucible and the vessel by rotating an assembly comprising the support, the vessel, and the crucible, the crucible closing the vessel and preventing dust from being emitted during the crushing operation. (J.C.W.)

19133 CONSTRUCTION OF AN EXPERIMENTAL LOOP. Martinek, J.; Mlynarik, J.; Novotny, K. Skoda Rev., No. 6, 53-6(1968).

The design, construction, uses, and auxiliary equipment of the SKODA experimental loop are described. The loop consists of a cold and hot circuit and filling equipment. The working medium is dry pure CO_2 or air with variable parameters within a given range. The principal technical parts of the hot circuit are a single-stage centrifugal compressor, in which the medium circulates in a closed circuit, a regenerative heat exchanger, a heat exchanger with combustion chamber, a water cooler, an impurity separator, and the connecting piping. The cold circuit contains the same circulating compressor, a water cooler, an impurity separator, and the connecting piping. The installation will serve for the investigation and testing of fuel elements, control mechanisms, piping, and other parts of the primary circuit of nuclear power stations. (J.C.W.)

19134 THE ELECTROMAGNETS USED IN NUCLEAR RESEARCH. APPLICATIONS, TECHNOLOGY, REQUISITE SUPPLY CONDITIONS. Baud, A. Rev. Gen. Elec.; 78: 735-41(Jul-Aug 1969).

The development of fundamental research in nuclear physics calls for increasing use of magnetic fields of various configurations. Following classification of the different types of electromagnets according to application, a review of the technology of this equipment is given. In particular, the characteristics of the steel and copper used and the manufacture of the various constituent parts of an electromagnet; magnetic circuit, coils, vacuum chamber and auxiliaries are discussed. The operating conditions set by the accuracy of the magnetic field law require a stabilized supply of electricity obtained either by current regulation or directly from the field of the electromagnet. (Sum. Articles Fr. Tech. Press)

19135 HEAT BARRIER IN IRRADIATION CAPSULES. Geiser, Richard; Haas, Roland; Steven, Gunter; Zeisser, Peter (to European Atomic Energy Community). British Patent 1,185,001. 18 Mar 1970. Priority date 19 May 1967, Belgium.

The design of a gas-filled double skin heat barrier in an irradiation capsule is given. The width of the slot or space depends upon the heat flow to be removed and the temperature. The design provides means for varying the space width over the capsule if the heat emission of the specimen is not uniform over the capsule surface (that is, because of variations in fissile product concentrations or because the radiation is uneven if the capsule is disposed at one side of the reactor core). (J.C.W.)

19136 SHIMADZU ROTATIONAL RADIOISOTOPE THERAPY UNIT RTGS-2. Ueyanagi, Hideo; Kinoshita, Katsuhiro; Omae, Sakae (Shimadzu Seisakusho Ltd., Kyoto). Shimazu Hyoron; 26: 417-22(Dec 1969). (In Japanese).

The Shimadzu RTGS-2, a new ^{60}Co therapy unit developed for treatment of tumor in 1968 by Shimadzu Seisakusho Ltd., is described. The new unit can contain up to 12,000 curies of a cobalt source though this may be limited by the specific activity of the source to be used. This unit can be attached with various accessories for accurate and easy positioning and a variety of treatment techniques. (auth) (NSA of Japan)

19137 EXPERIMENTAL FOOD IRRADIATION INSTALLATION. Hirling, Jozsef (Isotope Inst., Budapest). Atomtech. Tajek.; 12: 293-312(1969). (In Hungarian).

The Central Research Institute for the Food Industry established a 50,000 Ci ^{60}Co γ-radiation source in Budapest for the purpose of carrying out experiments on food preservation by irradiation. The radiation source was located in an artificial cave created by limestone-quarrying operations; the 9-m thick roof and 5-m thick stone walls provided and excellent shielding for the source. The same basement area was used for food and vegetable storage. The 48 individual sources with a nominal activity of 1200 Ci each were welded in stainless steel capsules and arranged in cassettes which could be displaced as desired to change the height of the irradiated space. The sources are stored under water in a pool. The operations may be carried out remotely from the control room. Radiation safety devices and double-lock systems provide the necessary protection for the operators. Provisions were made to remove the water if it becomes accidentally contaminated by means of a three-ton portable container. The new installation represents an advanced tool for food irradiation studies; it is competitive with the most recent foreign installations. (TTT)

19138 CONTINUOUS FLOW SODIUM CENTRIFUGE (Dec 1969) (Engineering Materials). (Atomic Power Development Associates, Inc., Detroit (Mich.)). (CAPE-1977).

38 drawings.

A centrifuge, to remove particulate impurities including elemental carbon and carbonates from Na, is described. The centrifuge is operated in an Ar atmosphere within a spherical glove box. The bottom-fed top-discharge centrifuge is suspended from a spindle, driven at speeds up to 50,000 rpm by an air turbine. A centrifugal force of 62,000 g is exerted on the walls of the bowl of the centrifuge. The Inconel X-750 bowl, which has a dia of 1.94 in., is located within an insulated and heated housing to control temperature before, during, and following operation with liquid Na. The Al-alloy spherical glove box is 36 in. in dia. The spherical configuration is rigid without using stiffening or reinforcing members. The front of the box is provided with a pair of glove ports in the lower hemisphere and a 10 in. in dia viewing port in the upper hemisphere. The rear of the box bas a pair of glove ports in the upper hemisphere and two glass-covered openings through the top plate of the centrifuge support frame provides viewing. Tests have established Na purification feasibility and capability of the equipment. Duration tests have sucessfully demonstrated mechanical performance. (For details see TID-4100 Suppl. 58) (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 19082, 19130, 19131, 19410–19416, 19491–19493, 19521, 20558, 20560–20562, 20568, 20626, 20640, and 20651.

19139 (HMI-B-89) BUBBLE MIGRATION IN ADAMANTANE BY SUBLIMATION IN A TEMPERATURE GRADIENT. Diez, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Feb 1970. 16p. Dep. CFSTI (U. S. Sales Only).

Experiments on the sublimation mechanism of bubble migration in adamantane have been performed. Flat bubble migrations in the [111] direction are analogous with the lenticular bubbles in UO_2. The formation of the equilibrium shape of gas bubbles at constant temperature and its transformation into the steady shape of migration in a temperature gradient was investigated experimentally. The velocity agrees with the theory, resulting in evaporation coefficients $\alpha_{III} = 5 \times 10^{-3}$ to 2.4×10^{-2} in the region of linear crystal growth. Sudden transitions in the velocity of very small bubbles (<5 μm) are explained by the mechanism of evaporation. (auth)

19140 TWO-PHASE FLOW AND HEAT TRANSFER IN ROD BUNDLES. The Winter Annual Meeting of The American Society of Mechanical Engineers, Los Angeles, California, November 18, 1969. Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969). 99p. $11.00. (CONF-691117).

Nine papers on two-phase flow and heat transfer in rod bundles are presented. Separate abstracts were prepared for each. (L.C.L.)

For abstracts of individual papers see: 19141–19149.

19141 MIXING, FLOW REGIMES, AND VOID FRACTION FOR TWO-PHASE FLOW IN ROD BUNDLES. Lahey, R. T.; Schraub, F. A. (General Electric Co., San Jose, Calif.). pp 1-14 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E.

(ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

The present state of understanding and available data on two-phase mixing, void fraction, and flow regimes in multirod bundles are reviewed. Considerable current work is underway on mixing; it is primarily motivated by the desire to obtain more precise subchannel flow and enthalpy data for models which predict the critical heat flux in water-cooled nuclear reactors. Less extensive data are available on multirod flow regimes and void fraction, largely due to the experimental difficulties involved. (auth)

19142 TWO-PHASE PRESSURE DROP AND HEAT TRANSFER IN ROD BUNDLES. Castellana, F. S.; Bonilla, C. F. (Columbia Univ., New York). pp 15-30 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

The basic equations which govern two-phase pressure drop are summarized, and correlations for void fraction and for two-phase friction in both the subcooled and bulk boiling regimes are considered. Pressure drop due to grids and spacers is also covered. These methods are then extended to rod bundles using both the single equivalent diameter and the subchannel analysis techniques. Available computer programs for subchannel analysis (COBRA-I, CORAL, and HAMBO) are compared with recent rod bundle pressure drop data. The significance of heat transfer coefficient information is discussed, and available data on closely packed uniformly heated rod bundles in forced convection vaporization are correlated. Recent liquid-deficient or post-CHF vaporization heat transfer data for rod bundles are compared with Miropol'skiy's correlation, which is seen to be conservative for bundles with wire wraps. (auth)

19143 CRITICAL HEAT FLUXES IN ROD BUNDLES. Tong, L. S. (Westinghouse Electric Co., West Mifflin, Pa.). pp 31-46 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

The published rod-bundle critical heat flux (CHF) data and correlations used by the nuclear industry are tabulated. The analytical method for predicting CHF in a rod bundle is discussed with experimental evidences. The parameter effects on CHF, presented in the most recent papers, are summarized. The data of transient CHF tests are introduced. The tested transient conditions include power excursion, flow coastdown, and pressure blowdown. The values of uncertainties of CHF are evaluated and summarized. The effect of boiling crisis in a rod bundle is estimated based on experimental evidences. (auth)

19144 TWO-PHASE FLOW STRUCTURE OBSERVATIONS FOR HIGH PRESSURE WATER IN A ROD BUNDLE. Bergles, A. E. (Massachusetts Inst. of Tech., Cambridge). pp 47-55 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

Flow regime and annular film thickness observations are presented for adiabatic and diabatic two-phase flow of water at 1000 psia in a four-rod bundle. Traversing electrical resistance probes were used to obtain this information for representative subchannels. It is demonstrated that wide variations in flow regime and annular film thickness can exist in the various subchannels at a given operating condition. (auth)

19145 CRITICAL HEAT FLUX IN A NONUNIFORMLY HEATED ROD BUNDLE. Wilson, R. H.; Stanek, L. J.; Gellerstedt, J. S.; Lee, R. A. (Babcock and Wilcox Co., Lynchburg, Va. Babcock and Wilcox Co., Alliance, Ohio). pp 56-62 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

The critical heat flux results from a 9-rod, 6-ft-long bundle with a nonuniform axial heat flux profile are presented. The data cover the following parameter ranges: average mass velocity of 1.0×10^6 to 3.5×10^6 lb/hr-ft^2; average exit steam quality at CHF of +2 to +25%; and pressure of 2000 to 2400 psia. Data were also obtained from tubular single-channel test sections with both uniform and axially nonuniform heat flux shapes. These data were used to develop a flux shape correction factor for converting the bundle uniform flux correlation to the axially nonuniform situation. Using the B&W-2 equation and the nonuniform flux factor, the nonuniform bundle performance is predicted to within a standard deviation of 0.1148. (auth)

19146 CORRELATION OF CRITICAL HEAT FLUX IN A BUNDLE COOLED BY PRESSURIZED WATER. Gellerstedt, J. S.; (Babcock and Wilcox Co., Alliance, Ohio); Lee, R. A.; Oberjohn, W. J.; Wilson, R. H.; Stanek, L. J. pp 63-71 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

Critical heat flux data from a 9-rod, 6-foot-long bundle with a uniform axial heat flux profile are presented. Included with the presentation of the data is a discussion of flow regimes and pressure effect. The experimental results cover the following ranges of parameters; average mass velocity of 0.2×10^6 to 3.5×10^6 lb/hr-ft^2; average steam quality at CHF of −5 to +75%; and pressure of 1000 to 2400 psia. The data have been used to develop a critical heat flux correlation (B&W-2) applicable to the subchannels of a bundle geometry. The equation expresses the critical heat flux behavior of a bundle with uniform heat flux, both axially and rod-to-rod. The correlation is a function of local conditions and is restricted to the following limitations: local mass velocity of 0.75×10^6 to 4.0×10^6 lb/hr-ft^2; local steam quality at CHF of −3 to +20%; pressure of 2000 to 2400 psia; and subchannel equivalent diameter (based on wetted perimeter) of 0.2 to 0.5 in. Comparisons of the predicted and experimental results yielded a standard deviation of 0.07665. (auth)

19147 CRITICAL HEAT FLUX TESTS ON A COOLANT CHANNEL SIMULATING A CLOSELY SPACED LATTICE OF RODS. Green, S. J.; Saladna, E. F.; LeTourneau, B. W.; Sherba, P. S. (Westinghouse Electric Co., Pittsburgh). pp 72-80 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

Critical heat flux tests were conducted with vertical upflow of water at 1200 to 2000 psia on a uniformly heated 48-inch long channel that simulated a typical reactor coolant flow channel within a bundle of closely spaced rods. Two rod-to-rod spacings were simulated, 0.030 and 0.015 inch. The test results indicated that there was no adverse thermal effect produced by these relatively close spacings. The measured critical heat fluxes were in agreement with data previously obtained with rectangular channels having channel spacings of 0.050 and 0.097 inch indicating a negligible effect of channel spacing over the range 0.015 to 0.097 inch. (auth)

19148 SIXTEEN-ROD HEAT FLUX INVESTIGATION, STEAM-WATER AT 600 TO 1250 PSIA. Janssen, E.; Schraub, F. A.; Nixon, R. B.; Matzner, B.; Casterline, J. F. (General Electric Co., San Jose, Calif.). pp 81-8 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

Results for a 16-rod critical heat flux test program are described. Five test channels were used to determine the effect of "clean" channel versus channel with grid-type spacers, and the effect of uniform rods versus 1.25 peaking on the four center rods. The effects of quality, flow, and pressure on CHF are nearly the same as observed for nine rods. The effect of grid-type spacers on CHF is dependent on their axial position. With the last spacer located 4 inches before the end of the heated length, CHF is improved. With the last spacer located 18½ inches before the end of the heated length, CHF at higher flows is reduced. Flux peaking on the interior rods shows that they can sustain from 8 to 24% higher heat flux than can the corner rods before CHF occurs. Results are compared with results obtained by others. (auth)

19149 INVESTIGATION OF THE CRISIS OF FILM BOILING IN CHANNELS. Kalinin, E. K.; Yarkho, S. A.; Berlin, I. I.; Kochelaev, Yu. S.; Kostyuk, V. V. (Moscow Aviation Inst.). pp 89-94 of Two-Phase Flow and Heat Transfer in Rod Bundles. /Schrock, V. E. (ed.). New York; The American Society of Mechanical Engineers (1969).

From ASME Annual Meeting of Two-Phase Flow and Heat Transfer in Rod Bundles, Los Angeles, Calif. See CONF-691117.

The film boiling crisis was investigated in vertical channels under conditions of free and forced convection. It was discovered that the crisis of film boiling has thermodynamical character under these conditions. Its beginning and end are defined by the

wall surface temperatures. The mechanism of the crisis and its dependence on different variables were analyzed. Correlations generalizing the wall surface temperature data of beginning and end of film boiling crisis for liquids having zero boundary angle of wetting were found. It was expected that these temperatures would define thermodynamical crisis of nucleate boiling but in reverse sense. (auth)

19150 SIMULTANEOUS DETERMINATION OF MICROLAYER GEOMETRY AND BUBBLE GROWTH IN NUCLEATE BOILING. Jawurek, H. H. (Atomic Energy Board, Pretoria). Int. J. Heat Mass Transfer; 12: 843-8(Aug 1969).

An optical technique is described which permits the simultaneous determination of detailed microlayer geometry and macroscopic bubble dynamics in nucleate boiling. Boiling takes place from a transparent heating surface forming the floor of a tank. With parallel, monochromatic illumination from below, the microlayers reflect interference patterns similar to Newton's rings. These fringe patterns are recorded by a high-speed ciné camera and provide details of microlayer shape and thickness. Simultaneously, and on the same film, normal bubble-growth pictures in profile are obtained. The optics of the system are analysed. Sample results are discussed. (auth)

19151 EFFECT OF POWER TRANSIENTS ON THE PEAK HEAT FLUX. Roemer, Robert B. (Stanford Univ., Calif.). Int. J. Heat Mass Transfer; 12: 953-64(Aug 1969).

An experimental investigation of the effect of power transients on the peak heat flux has been conducted for external flow of water normal to cylindrical test elements. Two sets of tests were run: The first set, using steps and one minus negative exponentials in the test element voltage, shows that if a power transient is applied to a test element when air is present on its surface the transient peak heat flux may be as low as 25% of the corresponding steady state flux; in the second set of tests surface temperature measurements indicate that for steps in power the tube wall temperature variation during the approach to steady state conditions is close to that predicted for transient conduction from the element. (auth)

19152 MICROLAYER AND BUBBLE GROWTH IN NUCLEATE POOL BOILING. Cooper, M. G. (Cambridge Univ., Eng.). Int. J. Heat Mass Transfer; 12: 915-33(Aug 1969).

A theory is presented to determine the rate of growth of a vapor bubble growing from a heated wall in a liquid which is near to saturation temperature. The theory depends on approximate assumptions derived from experiments in which thin liquid layers (microlayers) were observed to occur under such bubbles, and in which the evaporation of the microlayers contributed significantly to the growth of the bubbles. To simplify the analysis it is based on assumptions representative of more extreme situations in which the microlayer predominates, extremes which have not previously been explored. The predictions of the analysis bear some relation (±25%) to the results of experiments with various fluids under conditions for which the assumptions are approximately valid. These predictions, with associated limitations on the ranges of validity of the assumptions, together indicate conditions under which microlayers may be expected to have significant effects on bubble growth. They also have implications for bubble departure size, at standard and reduced gravity. Water, organic liquids, cryogens and metallic fluids are discussed. The theory is extended to include boiling with liquid bulk temperature differing significantly from saturation temperature. (auth)

19153 SATURATED BOILING HEAT TRANSFER IN NARROW SPACES. Ishibashi, E. (Hitachi Ltd., Japan); Nishikawa, K. Int. J. Heat Mass Transfer; 12: 863-94(Aug 1969).

The results of a series of experiments conducted to clarify the space restriction effect on the saturated boiling heat-transfer phenomena are reported. It was found that for saturated boiling heat-transfer in a narrow space there is a coalesced bubble region which has very different characteristics from the isolated bubble region. Various characteristics of the coalesced bubble region are compared, and a new type of correlating equation for the coalesced bubble region is proposed. A theoretical analysis based on a simple unsteady-state thermal conduction model is described, and agreement with the correlating equation is demonstrated. (auth)

19154 LAPLACE-VARIATIONAL METHOD FOR TRANSIENT MULTIDIMENSIONAL TEMPERATURE DISTRIBUTIONS. Loretan, Philip A. (Tuskegee Inst., Ala.). Nucl. Eng. Design; 11: 27-40 (1969).

An analytical method has been developed which will provide closed form approximate temperature distributions for two-dimensional transient conduction heat transfer problems. It is referred to as a Laplace-variational method since it utilizes a Laplace transformation along with methods from the calculus of variations. The Laplace-variational method can be applied to bodies with or without heat generation. Application of the method to both of these types of two-dimensional problems is shown. Also, some one-dimensional and three-dimensional transient conduction heat transfer problems can be analyzed by the Laplace-variational method even though the method was formally prepared for two-dimensional problems. The procedure used to approach such problems by this method is outlined. Use of the Laplace-variational method in heat transfer problems means that the thermal properties of a material must be constant and also that a radiation boundary condition cannot be considered. Utilization of the technique has also been restricted to problems involving regular geometry. (auth)

19155 FREE CONVECTION OF HEAT GENERATING FLUIDS IN CYLINDRICAL TANKS. Essam, P. (Univ. of New South Wales, Kensington, Australia). Nucl. Eng. Design; 11: 57-68(1969).

Laminar, axisymmetric free convection of a uniform heat generating fluid which fills or partially fills a vertical cylindrical tank has been investigated theoretically, using finite difference methods to compute steady state nondimensional maximum temperatures and velocities. Tables of maximum temperatures and velocities are presented together with isotherm distributions and velocity vector diagrams for a range of Prandtl numbers ($0.1 \leq Pr \leq 10$), modified Grashoff numbers ($10 \leq Gr' \leq 10^4$) and fluid height to radius ratios (L/R) of 2:1 and 1:1. (auth)

19156 PROPAGATION CHARACTERISTICS OF COMPRESSION AND RAREFACTION PRESSURE PULSES IN ONE-COMPONENT VAPOR-LIQUID MIXTURES. Groimes, M. A.; Fauske, H. K. (Argonne National Lab., Ill.). Nucl. Eng. Design; 11: 137-42(1969).

Experimental data on propagation characteristics of compression and rarefaction waves in steam-water mixtures are presented. The front velocity of both types of waves are shown to be essentially the same and can be predicted if the flow regime is known. Differences and difficulties in interpreting the total pressure wave behavior of rarefaction and compression waves are also discussed. (auth)

19157 DYNAMICS OF WAVES INCLUDING SHOCKS IN TWO-PHASE FLOW. Fischer, M. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Eng. Design; 11: 103-31(1969).

Linear and non-linear wave propagation are investigated analytically for one-dimensional two-phase bubble flow with heat addition. Linear wave propagation results in weak shocks. The restriction to weak shock strengths leads to low velocities of sound with upper and lower limits in two-phase mixtures. Hence, the occurrence of shocks is probable in two-phase flows. The non-linear basic equations of two-phase bubble flow with heat addition are solved by the characteristics method. For stepwise calculation of the three dependent variables along the three characteristics a digital computer program was set up. The calculations showed that in compression waves the vapor is condensed almost completely under thermodynamic equilibrium. The pressure increase in the shock front then obviously leads to residual condensation. The existence of shocks is demonstrated for various boundary conditions. In two-phase one-component mixtures with small void fractions condensation in a compression wave causes a steep increase in the velocity of sound. For void fractions approaching zero the velocity of sound approaches the high velocity of sound of the saturated liquid. This greatly accelerates the convergence of characteristics in the case of compression waves. Hence, in two-phase flow a shock will always occur before complete condensation takes place in a compression wave. (auth)

19158 A RADIOACTIVE TRACER TECHNIQUE FOR MEASURING COOLANT MIXING IN NUCLEAR REACTOR FUEL SUB-ASSEMBLIES. Carelli, M. (Comitato Nazionale per l'Energia Nucleare, Bologna); Curzio, G.; Renieri, A. Nucl. Eng. Design; 11: 93-102(1969).

Coolant mixing in fuel sub-assemblies of nuclear reactors was studied and the commonly used methods for the experimental determination of the interchannel mixing flow rates in fuel sub-assembly models reviewed. A method employing a radio-active tracer is proposed. The radioisotope chosen is the β-emitter ^{32}P, and plastic scintillator rods or Geiger-Müller counters inserted inside the rods of the model are possible detectors. The main features of the method are described and calculated. The advantages of the proposed method are improved sensitivity, absence of perturbing probes and the possibility of evaluating the mean values of the tracer concentration in the sub-channel tested, as required for the calculations. Experimental values are reported of light attenuation in light pipes 10 mm in diameter and up to one meter long. Calculations of the detection efficiency were performed for many different geometrical configurations and sizes, showing good agreement with the experimental results. (auth)

19159 SENSITIVITY STUDIES IN THE OPTIMAL DESIGN OF A NATURAL-CIRCULATION BOILING WATER LOOP. Bandy, D. B.; Bankoff, S. G. (Northwestern Univ., Evanston, Ill.). Nucl. Eng. Design; 11: 77-92(1969).

Optimal control methods are applied to the design of the heating section of a natural-circulation boiling loop for maximum heat rejection rate, subject to a burnout safety margin. The design variables are taken to be the tube shape and the heat flux distribution. Significant increases in power over present-day designs are predicted. In addition, it is shown that the adiabatic section can be eliminated from the optimal design by decreasing the heater length, keeping the sum of the heater and chimney lengths constant, with only a slight decrease in power. The effects of the condenser pressure and the form of the burnout correlation are also investigated. Applicability of the model in nuclear power is discussed. (auth)

19160 STREAMWISE HEAT CONDUCTION EFFECTS IN FORCED-CONVECTION BOUNDARY LAYERS WITHOUT AND WITH SUPERPOSED FREE CONVECTION. Sparrow, E. M. (Univ. of Minnesota, Minneapolis); Heinisch, R. P.; Yu, H. S. Nucl. Sci. Eng.; 39: 387-93(Mar 1970).

An analytical study is performed to determine the threshold value of the Peclet number below which conventional Nusselt number relations are invalidated by the effect of streamwise heat conduction. The investigation encompasses the Prandtl number range of liquid metals. Consideration is given to pure forced-convection boundary layer flow on a flat plate and to the forced-convection boundary layer on a vertical plate with superposed free convection. If Pe_x, Re_x, and Gr_x, respectively, denote the Peclet, Reynolds, and Grashof numbers, all based on the streamwise coordinate x, then the threshold value of Pe_x is found to range from 12 to 7 as Gr_x/Re_x^2 ranges from 0 (pure forced convection) to 1.0. The present analysis does not provide Nusselt number results for very low Peclet numbers, where streamwise conduction effects play a decisive role. (auth)

Isotope Technology

Refer also to abstract 19158.

19161 (BMBW-FBK-69-44) DEVELOPMENT OF AN ISOTOPE FUELED THERMIONIC GENERATOR FOR ABOUT 30 W ELECTRICAL POWER. Batzies, P.; Birnbreier, H.; Fischer, W.; Gammel, G.; Koskinen, M. F.; Langpape, R.; Minor, A.; Schmid, H. E.; Uhing, E. (Brown, Boveri und Cie A. G., Heidelberg (West Germany). Zentrales Forschungslabor). Dec 1969. 108p. (In German). Dep. CFSTI (U. S. Sales Only).

A plane parallel thermionic energy converter which can be heated with a radioisotope has been developed. At an emitter temperature of 1800°K and a collector temperature of 1000°K the maximum electrical power output amounts to 36.5 W (9.1 W/cm^2). Considering the overall heat losses of converter and heat source, an overall efficiency of 10 per cent at 25 W electrical power output is to be expected. A prototype converter has been working for more than 3000 hours without any degradation. Tests have been conducted to improve the electrode efficiency and the power output. This has been done by preparing the emitter in adding cesium-oxide and in selecting appropriate collector materials. Studies have been performed about radioisotope generators for earthbound and space application. (auth)

19162 (HIT-412) SPHERICAL CAPSULE TECHNOLOGY PROGRAM. ADDENDUM TO THE HEAT SOURCE TECHNICAL REPORT. (Hittman Associates, Inc., Columbia, Md.). Jul 1969. 137p. Dep. CFSTI.

Work in several phases of the Spherical Capsule Technology Program is reported. The first involved full scale demonstration heat source tests including impact, vibration, and spinning plasma jet testing. The testing program and procedures are described. The impact tests showed that large, thin walled Haynes-188 capsules (with fuel simulant) can withstand impact on a granite surface at velocities greater than predicted reentry terminal velocities and at expected reentry impact temperatures of 1800°F, and resulted in a recommended capsule wall thickness of 0.55 in. The vibration tests showed that: silica foam will not crush even when subjected to loadings in excess of 500 g's; a constant preloading on the various heat source components during the launch environment is desirable and can be accomplished by using a metal felt material or a heat source mounting structure; when this preloading is maintained, the reference heat source design can meet all the Scout launch vehicle vibration specifications; and more support materials and methods should be tested, especially at heat source operating temperatures. No data was acquired on spinning heat source plasma arc due to cessation of heat source rotation during testing. Five subsized heat source models were designed, fabricated, and subjected to simulated aerodynamic stagnation reentry heat pulse in a plasma arc facility. The preliminary design of a full sized stagnation heat source assembly evolved. Two assemblies were fabricated and fire tested for ability to survive launch pad abort solid propellant fire conditions. One assembly tested without a reentry heat shield melted. The second heat-shielded assembly survived. The design, fabrication, and reentry heat pulse testing of a SNAP-19 IRHS assembly with silver-impregnated ceramic foam insulation and enclosed in a POCO graphite cover was completed. The post-test condition of all components was excellent, and the graphite ablation was tolerable. Three subsized models of this assembly were free fall drop tested (120 ft fall onto nonyielding surface). The post test condition of the spherical pyrolytic graphite assembly was good, and although the graphite was partially cracked it still provided adequate protection. The structural integrity of the Sander's wrapped graphite assembly after impact was excellent. (L.C.L.)

19163 (MLM-1611) STABLE GASEOUS ISOTOPE SEPARATION AND PURIFICATION: JULY-SEPTEMBER 1969. (Mound Lab., Miamisburg, Ohio). 9 Feb 1970. Contract AT-33-1-GEN-53. 44p. Dep. CFSTI.

Developments are reported for studies on: separation of carbon isotopes; separation of stable isotopes of argon, krypton, neon, and xenon; transport properties and column properties in thermal diffusion; and helium isotope separation and thermal transpiration. (J.C.W.)

19164 (ORNL-4510) A VACUUM DEPOSITION TECHNIQUE FOR THIN FILMS OF ^{210}Po ON ALUMINUM AND TITANIUM. O'Donnell, F. R.; Adair, H. L. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 11p. Dep. CFSTI.

A vacuum evaporation-condensation technique for coating aluminum and titanium substrates with thin uniform films of ^{210}Po is described. The resultant coatings were reproducible and were adherent to the substrates. Some of the ^{210}Po was ejected from the surfaces as a result of nuclear recoil-induced sputtering. The coating techniques and apparatus required to obtain these films on disks and right circular cones are described. (auth)

19165 (ORNL-TM-2889) ISOTOPE PROGRAM (5000) PROGRESS REPORT FOR QUARTER ENDING DECEMBER 31, 1969. Gillette, J. H. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 16p. Dep. CFSTI.

Progress is summarized on target fabrication and development, isotopic separations, radioisotopic separations, sector isotope separator operation, chemistry of processing, and isotope sales. (J.R.D.)

19166 (ORNL-tr-2223) USE OF THE CYCLOTRON FOR THE PRODUCTION OF RADIONUCLIDES. Seelmann-Eggebert, W. Translated by Lynda H. Kern and J. J. Pinajian (Oak Ridge National Lab., Tenn., from Atomwirt., Atomtech.; 6: 273-7(1961). 16p. Dep. CFSTI.

Reaction mechanisms are discussed for the production of radionuclides in a cyclotron. A comparison was made of the advantages and disadvantages of isotope production in reactors and in cyclotrons. The Karlsruhé cyclotron is a new type producing a beam current of high intensity and high projectile energy. The economics of the production of the radionuclides is considered. (J.C.W.)

19167 (ORO-674) THREE METHODS OF EVALUATING CAPITAL EXPENDITURES IN THE PUBLIC SECTOR IN WHICH THE TIME VALUE OF MONEY CONCEPT IS USED. Arnold, St. George Tucker (Oak Ridge Operations Office (AEC), Tenn. Operational Planning and Power Div.). Dec 1969. 153p. (OPP-4(Rev.2)). Dep. CFSTI.

Three proven and accepted methods of evaluating capital expenditures are discussed and applications presented. The concept that the value of money is time related is used in each method. This concept holds that a dollar in hand is worth more than a dollar due in the future. The three methods are annual cost, present worth, and rate of return. Sensitivity analysis and dealings with uncertainties in forecasts are discussed. Examples of analyses at US nuclear installations are made. (J.C.W.)

19168 (SC-DR-69-848) DYNAMIC ANALYSIS OF SIMULATION TECHNIQUES FOR FUEL DISC EARTH IMPACT. Duffey, T. A. (Sandia Labs., Albuquerque, N. Mex.). Jan 1970. 25p. Dep. CFSTI.

Two techniques currently used to simulate the earth impact of exposed fuel discs are modeled in one-dimensional strain. A linear elastic constitutive relation and simple graphical constructions are used to crudely examine the first few stress wave-interface reactions in each of the two impact simulation schemes.

It is shown that both schemes are equally valid simulations for the special case in which target and fuel containment materials are identical. If target and container are constructed of dissimilar materials, as will generally be the case, it is shown that only one of the testing techniques is an exact simulation. (auth)

19169 (WANL-3800-41) SNAP-23A, PHASE 1. Quarterly Progress Report, September 1, 1969–November 30, 1969. Wilgus, W. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Jan 1970. Contract AT(30-1)-3800. 116p. (WANL-PR(SS)-34). Dep. CFSTI.

Research and development are reported in sections on program managment, product assurance, materials and component testing, systems development, and safety analysis. (J.R.D.)

19170 UNDERWATER POWER SOURCES. Davie, Richard L. Oceanol. Int.; [4]: 31-3(15 Jun 1969).

Various power sources, some of which utilize nuclear energy, that are being designed for underwater applications are reviewed. A fuel cell oceanographic buoy power source is being developed that will provide up to 5 W, at 4 V, continuous electrical output for 1 yr. Total power system weight is about 300 lb. Radioisotope thermal electric generators (RTGs) have been developed through the prototype stage for low-level long-term energy source applications. Snap-21, a 10-W unit, has been designed and tested for deep submergence applications. Other commercially developed RTGs are available in the 1 to 25 W power range. Recently, the first commercial undersea application of an RTG was reported in the oilfields in the Gulf of Mexico. In this application, 3-W power supplies provide battery charging for operation of subsea wellhead control. These systems have an unattended life capability of at least 5 yr. (BBB)

19171 CARDIAC PACEMAKER RESEARCH. Heys, H. Electron. Equip. News; 11: 46-51(Feb 1970).

The reliability of implantable cardiac pacemakers under simulated body conditions and the protection of the electronics by encapsulation were studied. A long life battery was developed which converts the spontaneous heat generated by the radioactive ^{238}Pu into electricity using a thermopile. This battery is matched to the pacemaker circuit by a dc to dc converter. Safety factors are discussed. (UK)

19172 A ^{60}Co GAMMA IRRADIATION DEVICE. Doose, R.; Kolb, M.; Krull, W. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.). Kerntechnik; 12: 30-4(Jan 1970). (In German and English).

The design and construction of a ^{60}Co gamma irradiation device are described. The device is used for irradiating samples and for calibrating gamma dosimeters because it can be preset to an exactly reproducible exposure rate. The positions of the cobalt rods can be varied on the principle of an iris diaphragm so that the rods can be swung into a high exposure rate position (1.0 MR/hr) and a low exposure rate position (0.36 MR/hr). The device is designed for 2 kCi but was charged with only 1.15 kCi. Calculated and measured exposure rates inside and outside the device are compared, and the safety system for the prevention of mismanipulations and accidents is described. (auth)

19173 RADIONUCLIDES AS SOURCES OF ENERGY. Born, H.-J. (Technische Hochschule, Munich). Chem.-Ing.-Tech.: 42: 123-8(Jan 1970). (In German).

Radionuclide batteries are becoming increasingly important, particularly in telecommunications and medicine, because of their high stability, freedom from maintenance, and low space requirements. The most common methods for the conversion of radiation energy into electrical energy and the preparation and properties of a number of important nuclides are reviewed. The restrictions that generally apply to the use of such energy sources and the difficulties that stand in the way of commercial exploitation of such devices in the Federal Republic of Germany are discussed. (auth)

19174 RADIATION FOR INDUSTRIAL PROCESSING. Int. At. Energy Agency Bull.; 11: No. 6, 1-12(1969).

Radiation processing is now a useful production tool in industry. Every year raw material worth several hundred million dollars is irradiated and converted to newer and better products. The industrial aspects in radiosterilization of medical supplies and polymer processing are summarized. (auth)

19175 VSESOYUZNAYA NAUCHNO-TEKHNICHESKAYA KONFERENTSIYA XX LET PROIZVODSTVA I PRIMENENIYA IZOTOPOV I ISTOCHNIKOV YADERNYKH IZLUCHENII V NARODNOM KHOZYAISTVE SSSR, MINSKE, USSR, 7 PO 12 OKTYABRYA 1968 G. (All-Union Scientific Conference on 20 Years of Production and Use of Isotopes and Nuclear Sources in the Economy of USSR, Minsk, USSR, 7–12 October 1968). Millionshchikov, M. D. (ed.). At. Energ. (USSR); 26: 100-220(Feb 1969). (CONF-681061).

Twenty-one articles are included on the twenty years of production and use of isotopes and nuclear sources in USSR industry. The articles cover various phases of isotope applications including isotopes in scientific research, agriculture, geological prospecting, industry, food preservation, and in therapy. The use of the Moessbauer effect and radioisotope thermoelectric generators are also discussed. The application of radioisotopes in control and automation of technological processes, in radiochemistry, and medicine, methods for preparation of isotope tracers and labeled materials are reviewed. (R.V.J.)

19176 NUCLEAR ENERGY SOURCES. Hursen, Thomas F.; Kolenik, Steve A. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Contract AT(30-1)-3731. Ann. N. Y. Acad. Sci.; 167: 661-73(1969).

The design, fabrication, materials selection, operation, and performance of a plutonium-238-fueled cardiac pacemaker is described in detail. Two of these units have operated without degradation for approximately 6,000 and 3,300 hrs, respectively. The successful fabrication of these experimental devices demonstrates the feasibility of combining a nuclear-powered battery with conventional pacemaker electronics and cardiac leads to produce a pacemaker of satisfactory size and weight. (L.C.L.)

19177 ISOTOPE GENERATOR TRISTAN FOR TERRESTRIAL APPLICATIONS. Zahn, B.; Merges, V. (Messerschmitt-Boelkow-Blohm GmbH, Munich). Atomwirt., Atomtech.; 15: 142-5(Mar 1970). (In German).

The isotope generator Tristan is intended primarily for oceanographic use. Its main properties are as follows; ^{90}Sr source, 48 kilocurie; thermoelectric generator, 36 partial cascades with a first series of germanium-silicon components for temperature ranges from 250 to 900° C and a second series of bismuth-tellurium components for temperature ranges from 50 to 250° C shielding, lead sufficient to cut the external dose to below 200 mr/hour; container, resistant to seawater and to pressures up to 1000; electric power efficiency, 8%; and life expectancy, 5 years. More developmental work is suggested before the first prototype can be built. Preliminary test results are given. (H.B.G.)

19178 ETL ELECTROMAGNETIC ISOTOPE MASS SEPARATOR. I. DESCRIPTION OF THE RECONSTRUCTION. Nakai, Akira. Denki Shikensho Iho; 33: 1195-1207(1969). (In Japanese).

The reconstruction of the ETL Electromagnetic Isotope Mass Separator which was undertaken for the purpose of improving the overall performance and extending the flexibility in application of the machine is described. Most of the main parts of the machine including the power supply have been modified in accordance with new design consideration. The reconstructed machine exhibits a good performance in ordinary operation for isotope collection and also meets the requirements for recently developed techniques in such application of the machine as channeling, implantation of ions, etc. Experimental results are also included to demonstrate the overall performance of the machine. (auth)

Materials Testing

Refer also to abstracts 19162 and 19168.

19179 (FOA-2-2307) SOME VIEWPOINTS ON THE INTERPRETATION OF RADIOGRAPHS. Gylden, Nils; Andersson, Boerje; Andersson, Gunnar (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr 1969. 16p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

Factors which determine the rate of exposure of radiographic film were studied. The investigation was especially concerned with finding data for precise positioning of the subjects to be radiographed with the aid of a photometer. Different evaluation methods were compared, and it was found that a properly designed photometer system can reduce certain measuring errors considerably (by a factor of 2 to 5). (auth) (Sweden)

19180 BURSTING TESTS WITH CYLINDRICAL MODEL VESSELS OF STEEL. Vierling, P.; Bretfeld, H. (Krupp GmbH Zentralinstitut fuer Forschung und Entwicklung, Essen). Tech. Mitt. Krupp, Forschungsber.; 27: 91-100(Dec 1969). (In German).

Small cylindrical model vessels of single, double, and triple-layer construction were loaded to the bursting point. Suitable strain gages for high strains, cements, and covering means were tested. The measured bursting pressures were compared with calculated bursting pressures. (auth)

19181 NONDESTRUCTIVE TESTING OF SMALL-DIAMETER, STAINLESS STEEL FUEL CLAD TUBING. Ryden, Joseph Jr. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Mater. Eval.; 28: 67-71(Mar 1970).

Techniques used to inspect FFTF fuel cladding for defects are discussed. Descriptions are given of the three different testers used to inspect this tubing. They are a sinusoidal eddy current tester, an ultrasonic pulse-echo tester and an ultrasonic tester that uses a send-receive system of transducers. Micrographs, strip charts and statistical data obtained from the inspection of 20,000 feet of tubing are presented. (auth)

Protective Structures

Refer also to abstract 19092.

Radioactive Material Handling

Refer also to abstracts 19086, 19124, and 19125.

19182 (BNWL-tr-45) FIXATION OF HIGH ACTIVITY WASTES. 5th REPORT. HEAT GENERATION AND TEMPERATURE DISTRIBUTION IN BASALT AFTER FUSION WITH HIGH ACTIVITY WASTE. Ralkova, J.; Saidl, J. Translated by Elaine Foskett (Battelle-Northwest, Richland, Wash.), from Kernenergie; 10: 372-5(1967). 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 18875.

19183 (K-L-6252) ACTIVITY DETERMINATION FOR URANIUM HEXAFLUORIDE SHIPPING CYLINDERS. Newlon, C. E.; Taylor, R. G. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 10 Mar 1970. Contract W-7405-eng-26. 14p. Dep. CFSTI.

Formulae have been developed for the activity determination of uranium hexafluoride shipping cylinders. The methods outlined appear to be applicable for the activity determination of radionuclides in general. (auth)

19184 (MLM-1660) TESTING OF DISPOSABLE CONTAINERS FOR RADIOACTIVE WASTE. Madding, R. D. Jr.; Vallee, R. E. (Mound Lab., Miamisburg, Ohio). 23 Feb 1970. Contract AT-33-1-GEN-53. 37p. Dep. CFSTI.

Shipping containers for radioactive materials were tested according to Department of Transportation specifications for their ability to withstand a sequence of four tests: free drop, puncture, thermal exposure, and water immersion. The primary purpose of these tests was to develop a disposable container to ship dry radioactive waste for burial: two containers were approved for this purpose by DOT Special Permit No. 5915. All containers used 83- or 55-gal drums as the outer containment. Tests showed that vermiculite dampened with 25 vol % water provided good insulation around the inner containers, the size of which depended on the material to be shipped. No corrosion inhibitor was required in the damp vermiculite unless the containers were to be stored for long periods of time. Sponge rubber seals performed better than other gasket materials tested for the drums. Designs were also developed for disposable containers for radioactive sludge, for solid ^{238}Pu compounds, and for radioactive gas. The design of the reusable DOT Specification 6M container was modified with Firedike®, an asbestos-based insulation, and with fireproofed plywood spacers to pass the DOT tests. (auth)

19185 (ORNL-TM-2769) ORNL ISOTOPES DIVISION GUIDE FOR THE PACKAGING OF RADIOACTIVE MATERIALS FOR TRANSPORT. Seagren, R. D. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 98p. Dep. CFSTI.

The packaging requirements for radioactive material are presented in a referenced, condensed version of applicable regulations. The Guide provides the necessary information for packaging, labeling, and marking routine shipments from the Oak Ridge National Laboratory. As regulations undergo change, supplements to this Guide will be issued. (auth)

19186 (ORNL-TM-2782) MICROSPHERE HANDLING TECHNIQUES. Furman, F. J.; Meador, J. T.; Sease, J. D. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 26p. Dep. CFSTI.

Devices and techniques for remotely transferring, storing, classifying, blending, and inspecting 150- to 850-μ-dia. microspheres were developed. Particles are transferred both pneumatically and by gravity and routed by air-operated valves. Storage hoppers feed into the transfer system. Classification is by both size and shape. Large batches are blended by pneumatic stirring and small batches by concurrent pouring at a precise ratio. Particle size is inspected by both automatic and manual optical methods. (auth)

19187 (ORNL-TM-2845) SAFETY ANALYSIS OF ISOTOPES ALPHA HANDLING FACILITY. Hunter, H. G.; Schaich, R. W.; Setaro, J. A. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 55p. Dep. CFSTI.

A critical review of the hazards associated with operation of the Isotopes Alpha Handling Facility is presented. The physical facilities, operations, and operating procedures for the plant are described. Analyses were made of the operational hazards and it is shown that the primary and secondary containment features of the facility are adequate to contain the radioactive contamination to the confines of the facility. (auth)

19188 SHIPMENT OF IRRADIATED FUEL FROM ENEL'S LATINA NUCLEAR POWER TO CNEN'S EUREX PLANT AT SALUGGIA. Menichetti, Guido. Com. Naz. Energ. Nucl., Notiz.; 16: 29-31(Jan 1970). (In Italian).

A description is given of the method and equipment used for the shipment of irradiated fuel from ENEL's Latina Nuclear Power Plant to CNEN's Eurex Fuel Reprocessing Plant at Saluggia. This is the first shipment from an Italian plant to an Italian plant. (auth)

19189 PROBLEMS OF RADIOACTIVE WASTE DISPOSAL IN DDR. Richter, D.; Fischer, W. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie; 12: 314-21(Oct 1969). (In German).

Radioactive waste disposal problems in East Germany are discussed in terms of currently used waste disposal methods, estimates of the activities and amounts of waste which will result from the future use of nuclear power, and future possibilities for radioactive waste disposal including surface storage in water-insulated concrete vaults, underground storage in cavities in solid rocks and in salt formations, and the storage of radioactive gases. (auth)

19190 STORAGE OF NUCLEAR FUELS. (to Schoeller-Bleckmann Stahlwerke Aktiengesellschaft). British Patent 1,181,558. 18 Feb 1970. Priority date 22 Sep 1966, Austria.

A storage vessel for nuclear fuels is described in which machine shavings of a neutron absorbing metal are distributed in the vessel with the fuel. Boron steel may be used as the neutron absorber. (J.R.D.)

19191 AN ELECTROMAGNETIC PUMP WITH A BUILT-IN THERMOELECTRIC GENERATOR. Grassi, Giuliano (to Commissariat a l'Energie Atomique). British Patent 1,184,305. 11 Mar 1970. Priority date 7 Jun 1967, France.

A coffin for storage and handling nuclear fuel assemblies is described. Electromagnetic pumps are used for circulating electrically conducting liquid metals for cooling the assembly. An electric current is generated in the liquid metal in the pumps by the temperature difference between the pump and outside radiators. Most of the heat from the fuel assemblies is transferred to the vessel wall and to the outside by exchange. Very little heat is carried away from the fuel assemblies by the radiators associated with the circulation pumps. (J.R.D.)

Vacuum Engineering

Refer also to abstract 19268.

19192 FIRST INTERNATIONAL CONFERENCE ON APPLICATIONS OF VACUUM SCIENCE AND TECHNIQUES TO COATING AND SURFACE FINISHING, DIJON, FRANCE, OCTOBER 15-19, 1968. Vide, Suppl.; No. 136, 1-277(1968). (In French). (CONF-681048).

A total of 41 papers were presented at the conference on the applications of vacuum science and techniques to coating and surface finishing. Separate abstracts were not prepared for any papers. (J.C.W.)

19193 HIGH-FIDELITY SOLAR SIMULATION FOR AN ULTRA-HIGH VACUUM FACILITY. Wornom, Dewey E. (Langley Research Center, Hampton, Va.); Benning, F. N. J. Spacecraft Rockets; 7: 220-1(Feb 1970).

Design and performance of a 150 ft^3-volume space vacuum facility is described. Methods of attaining solar simulation are described along with the performance of the solar simulator. (J.R.D.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 20546.

General Detectors and Monitors

Refer also to abstracts 18911, 19250, 19325, and 20272.

19194 (BARC–452) B.A.R.C. MODEL 228 DETECTOR BIAS SUPPLY. Gogate, S. A.; Sule, S. G. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 4p. Dep. CFSTI (U. S. Sales Only).

Circuit design and specifications for the BARC model 228 power supply which provides the bias voltage of either polarity for a semiconductor detector are described. (W.H.K.)

19195 (CEA-CONF–1480) STUDY OF THE LIGHT EMISSION OF ELECTRON AVALANCHES IN BINARY MIXTURES ESSENTIALLY CONTAINING XENON. INTERPRETATION OF THE VISIBLE CONTINUUM EMITTED BY XENON. Morucci, J. P.; Lansiart, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 22p. (In French). (CONF-700301–2). Dep. CFSTI (U. S. Sales Only).

From 12th Scintillation and Semiconductor Counter Symposium, Washington, D. C.

The spectral distribution of an electron avalanche for different binary mixtures (xenon + methylal or methane or diethyl amine) was studied at atmospheric pressure. A continuum spectrum is obtained, on which lines are superimposed. These lines disappear as the ionizing potential of the vapor decreases but the visible continuum, which constitutes the main part of the light, remains constant. Therefore, the emission mechanism of the visible light emitted by xenon was studied. An important emission of visible light takes place even when there is no xenon excited state. Only the direct electron-xenon molecule interaction can explain this phenomenon and leads to the introduction of the molecular ion Xe_2^+. (France)

19196 (CTC–26) AN INVESTIGATION OF THE USE OF A DIGITAL COMPUTER FOR PROCESSING RADIOISOTOPE SCAN DATA. McClain, W. J. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 27 Mar 1970. Contract W-7405-eng-26. 209p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

Radioisotope scanning is a very useful diagnostic procedure in the field of nuclear medicine. Activity maps, displayed as two-dimensional plots with varying intensities, provide a means by which clinicians can detect abnormal or malfunctioning tissue in vital organs. Two major factors limit the detectability of tumors in a scan display: (1) the response of the imaging system and (2) the statistical variations in the detected counts. The objective of this study was to determine the effectiveness of a digital computer in overcoming these limitations. The investigation included the development of the hardware and software required for on-line computer operation. The theoretical background and results of the use of six algorithms are included. Common data obtained from a scan of the standard IAEA phantom having a fifty-percent tumor-to-background contrast were used. The data were displayed on a laboratory cathode-ray oscilloscope to provide a comparison of the detectability of tumors in the processed data. An inverse-iterative algorithm used to compensate for the low-pass detector response was thoroughly investigated using simulated scan data. Convergence was obtained and some compensation accomplished in only two iterations using data having no statistics; however, the results diverged in all cases in which statistical variations were present. Smoothing of statistical fluctuations was investigated using two-dimensional low-pass digital filters, developed from the one-dimensional data-averaging, polynomial least-squares, and Gaussian filters. Displays of data processed by these filters contained excessive reduction in contrasts, although tumors in the phantom were more discernible than in displays of the unprocessed data. This reduction is contrast was alleviated by use of a dynamic filtering algorithm. Tumors having both low and high uptake were easily detected in displays of data processed by this method. Two algorithms permitting special investigations of scan data were developed. Statistical tests using a truncation of the Poisson distribution of the data permitted tumors to be extracted from their background by eliminating the background population. The use of chi-squared tests with five percent confidence interval permitted recognition of tumors with as little as thirty percent tumor-to-background contrast. Definition of boundaries of organs was accomplished by an algorithm which determined the locations at which the Compton scatter counts approached the peak counts in the scan. This investigation proved that the information content of radioisotope scans can be enhanced by digital-computer processing. Proper implementation of the computer in this application, however, requires an on-line operation, immediate display, and specialized resources. (auth)

19197 (DESY–69/49) STRUCTURE OF THE GAS DISCHARGE IN THE PROPORTIONAL AND GEIGER ZONE FOR USE IN CHARPAK CHAMBERS. Stuckenberg, H.-J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Dec 1969. 25p. (In German). Dep. CFSTI (U. S. Sales Only).

The gas discharge process of ionization chambers operating in the proportional and in the Geiger–Mueller regions is described. The discharge process is studied for both self-quenching gas fillings and non self-quenching gases. (W.H.K.)

19198 (FMRB–15/69) SIGNAL-NOISE RATIO AND TIME RESOLUTION FOR NUCLEAR RADIATION SPECTROSCOPY USING SEMICONDUCTOR DETECTORS. Schuster, H. J. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Mar 1969. 63p. (In German). Dep. CFSTI (U. S. Sales Only).

It is shown how the energy and time resolution can be improved in the measurement of the energy of radiation particles (nuclear spectroscopy) by the use of a new pulse former. For this purpose a typical measurement system (nuclear radiation detector, charge-sensitive preamplifier, linear amplifier, pulse former, and pulse-height analyzer) was described and its limits of energy and time resolution were studied. This study showed that these limits with semiconductor detectors are set principally by the noise of the amplifier. The total noise voltage behind the linear amplifier was analyzed. The signal-noise ratio and the resolution time were introduced as the measurement of the energy and time resolution, and the dependence of these magnitudes on the pulse former was derived. After a brief review of known pulse transformers, a time-dependent filter acting as a new pulse former was described and studied with respect to the signal-noise ratios and the resolution time. It was shown that these magnitudes were greatly improved by the time-dependent filter. The signal-noise ratio attained is only about 3% smaller than the best possible according to information theory. The time-dependent filter was built and tested in various experiments. The theoretical results were confirmed experimentally. (tr-auth)

19199 (HASL–222) TECHNIQUE FOR DETERMINING MODERATED-NEUTRON INSTRUMENT CHARACTERISTICS. Hajnal, Ferenc; McLaughlin, James E.; Oechsler, Ronald (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Feb 1970. 25p. Dep. CFSTI.

Reproducible measurements with moderated-neutron detectors were made for polyethylene spheres and a DePangher precision long counter (PLC). Data analyses were performed using both DePangher's technique for a PLC where the scattered neutrons are constant and Lindenbaum's model for accelerator skyshine where the scatter is distance and medium dependent. The agreement of the detector characteristic and sensitivity values from the two analyses was very good for the PLC and adequate for the moderating spheres. Agreement with published sensitivity values was also good. Taking account of spectral dependence, the PLC results from the Pu-Be measurements reproduced the ^{252}Cf neutron yield well within experimental errors. The moderating sphere results agreed with the ^{252}Cf source yield only to within about 10%. To apply this work to neutron energies below about 1 MeV, the response of the PLC should be evaluated as the ICRU has recommended. The small sphere responses should be reevaluated for a point-source geometry and fairly narrow energy bins to reduce the observed discrepancy. (auth)

19200 (INR–1135) SILICON DETECTORS OF NUCLEAR RADIATION FROM HOMEGROWN PRODUCTION MATERIAL. Belcarz, E.; Chwaszczewska, J.; Przyborski, W.; Wojciechowska, W. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 12p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The characteristics of Si(Li) detectors, Si(Li) detectors with surface barrier and Si(Li) detectors with surface barrier and with the guard-ring were studied. The detectors were prepared from either imported or homemade material. The optimum temperature conditions with respect to the maximum energy resolution has been found. (auth)

19201 (MIT–952–6, pp 164–84) INSTRUMENTATION TECHNIQUES. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

Topics include the development of a scintillation survey meter, improved low background alpha-scintillation counting methods for the detection of radon-222, operation of the 4-channel alpha scintillation counter, and the fabrication of semiconductor counters. (W.H.K.)

19202 (N–70–13082) COSMIC RAY PARTICLE DETECTORS DESIGNED FOR INTERPLANETARY STUDIES UTILIZING THE PIONEERS 8, 9, AND 10 SPACECRAFTS. Final Report. Bukata, R. P.; Keath, E. P.; Younse, J. M. (Texas Univ., Dallas). Oct 1969. Contracts NAS2-3332; NAS2-4674. 41p. (NASA-CR-73388). CFSTI.

The design, development, fabrication, and initial data reduction history of the cosmic ray detector packages for the Pioneers 8–10 deep-space probe missions are briefly summarized. This is intended to supplement 8, 9, and 10 missions. Discussed are the three somewhat general categories: (1) the time-history of the program development; (2) a description of the particle detectors, along with preliminary data obtained from Pioneer 8; and (3) techniques employed in the reduction of the scientific data telemetered back to earth. (auth) (STAR)

19203 (RD/B/N–1576) SMALL AREA CONTAMINATION MONITOR CONCEPT USING A SILICON P–N JUNCTION DETECTOR. Walker, W. N. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 10p. Dep. CFSTI (U. S. Sales Only).

A method of designing a small area contamination monitor or surface dose hot spot monitor is described. Such an instrument would use a silicon junction detector in a novel circuit which provides a wide range of operation and avoids leakage current problems in the detector. The specification of a suggested prototype instrument is given. (auth) (UK)

19204 NUCLEAR-PARTICLE-TRACK IDENTIFICATION IN INORGANIC SOLIDS. Fleischer, R. L.; Price, P. B.; Woods, R. T. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev.; 188: 563–7(10 Dec 1969).

The unique feature of track-recording plastics which allows them to be used to identify particles is that the chemical rate of attack V_T along a track is an increasing function of ionization rate. This same characteristic is shown to extend to inorganic dielectric solids. The relation between V_T and ionization rate has been measured for five different glasses, using fission fragments of different energies. The variation of V_T is least for ordinary lime glass and much the greatest for a phosphate glass, suggesting that the latter should be useful in resolving atomic numbers and energies of fission fragments and other very heavy, energetic nuclei. Equations are derived that allow the shapes of etched tracks to be calculated as a function of etching time and particle ionization rate. The calculations agree well with recent experimental results. (auth)

19205 CORRECTION METHODS FOR PHOTON PILE-UP IN LIFETIME DETERMINATION BY SINGLE-PHOTON COUNTING. Davis, C. C.; King, T. A. (Manchester Univ., Eng.). J. Phys., A (London); 3: 101–9(Jan 1970).

The distortion of photon-count distributions from single photon counting at high count rates is discussed with consideration of its use in excited-state lifetime measurements. An inhibit function technique is described which facilitates collection of data at high count rates. (UK)

19206 A QUENCHING CIRCUIT OF VERY SHORT RISE TIME FOR GEIGER–MUELLER COUNTERS. Kemplay, J. R. (Westminster Hospital, London). J. Phys., E (London); 3: 251(Mar 1970).

Comments are made on the equipment described by Eckey (J. Phys. E: 2: 1121–2. Dec. 1969). The merit of a short rise time for G. M. counters is queried and the availability of comparable commercial equipment discussed. Some remarks are made on the circuit design and reliability. (UK)

19207 RELATIVISTIC IONIZATION INCREASE AND IONIZATION EFFECTS IN NUCLEAR PHOTOEMULSIONS. II. AVERAGE SENSITIVITY OF EMULSION CRYSTALS AS A FACTOR DETERMINING THE RELATIVISTIC RISE IN DENSITY OF DEVELOPED GRAINS. Skirda, N. V. Zh. Nauch. Prikl. Fotogr. Kinematogr.; 14: 413–20(Nov–Dec 1969). (In Russian).

A model of a relativistic increase in grain density based on the determining role of the average size of the emulsion crystals has been found to be in clear contradiction with experiment. A model where the dominant factor is the sensitivity of the emulsion crystals is presented. Supporting experimental data will be presented in a subsequent work. The energy spectrum of delta electrons liberated by a fast particle in a nuclear emulsion is discussed. The energy required to form a latent image of the particle track is estimated, and the relation of this energy to a linear density of the activated crystals is pointed out. The density of the developed crystals is related to energy losses of the charged particle. The relativistic increase in grain density is shown to be a function of the average sensitivity of the emulsion crystals. (TTT)

19208 ENERGY TRANSFER IN PLASTIC SCINTILLATORS. Heisel, Francine; Laustriat, Gilbert (Centre de Recherches Nucleaires, Strasbourg). J. Chim. Phys.; 66: 1895–1902(Nov–Dec 1969). (In French).

The variation of the solvent-solute energy transfer efficiency with the nature and concentration of solute has been determined in plastic polystyrene scintillators. The respective contributions of the radiative and non-radiative processes were evaluated; the non-radiative transfer process was shown to result from a dipolar resonant interaction between the excimers and the solute. It seems moreover that there is no energy migration in the solvent, which is in agreement with the fact that excimer formation is very efficient. (auth)

19209 MEASUREMENT OF THE DECAY TIME OF SCINTILLATION INTENSITY BY CORRELATION ANALYSIS. Aurich, F. (Technische Univ., Berlin). Chem. Phys. Lett.; 4: 573–4(15 Jan 1970).

The autocorrelation function of scintillations of an organic phosphor excited by radiation was measured, yielding a luminescence decay time of 0.4 nsec for the scintillating compound. A correlator with high time-resolution is described. (auth)

19210 STUDY OF A NEW METHOD FOR PRODUCING ZnS SCINTILLATORS. Nardi, A.; Scacco, F. (CSN–CNEN, Rome). G. Fis. Sanit. Prot. Radiaz.; 12: 296–300(Oct–Dec 1968). (In Italian). (RT/PROT–(69)29).

The radioactive contamination measurements from α-emitters, owing to the contamination levels concerned, require high-sensibility and low-noise radiation detectors. Many of the detectors commercially available, however, do not allow the measurement of contaminations of the same order of the values used as "working limits." For this purpose, a technique to produce α-scintillators which are able to achieve the required performances, is described. (auth)

19211 SURVEY OF MEDICAL GAMMA-RAY CAMERAS. Moody, Norman F.; Paul, William; Joy, Michael L. G. (Univ. of Toronto). Proc. IEEE (Inst. Elec. Electron. Eng.); 58: 217–42(Feb 1970).

Visualization of isotope distribution within the living body has created important medical diagnostic procedures during the last decade. The static gamma-ray cameras reviewed here are often replacing the earlier mechanical scanners because of their ability to reduce picture exposure times: in extreme cases from minutes to tenths of seconds. Motion picture photography of changing isotope distribution can thus be used to follow many physiological processes which were previously a mystery, and these dynamic studies offer completely new diagnostic methods. The development of static gamma-ray cameras is reviewed, the problems of their design are discussed, and the limitations of each type are evaluated. Methods of judging camera quality are discussed, and there is also brief mention of analytical methods for picture assessment. (66 references) (auth)

19212 NEITRONNYE SPEKTROMETRY I IKH PRIMENENIE V PRIKLADNYKH ZADACHAKH. (Neutron Spectrometers and Their Applications). Stolyarova, E. L. Moscow, Atomizdat, 1969. 240p.

Topics include spectra measurement, neutron spectra analysis, and practical applications of neutron spectrometers. The main attention was devoted to fast neutron spectroscopy (1 to 30 MeV). Time-of-flight methods, photoplate and thick-layered emulsion detectors, semiconductor detectors, threshold detectors, and monocrystal and polycrystal scintillation detectors are discussed. (auth)

19213 INVESTIGATION OF THE LIGHT YIELD OF GASEOUS SCINTILLATORS. Koehler, H.; Peter, G.; Rosenkranz, G. (Institut fuer Experimentelle Kernphysik, Dresden). Kernenergie; 12: 387–90(Dec 1969). (In German).

The behavior of gaseous scintillators with and without applying an electric field has been studied by means of alpha-rays. The excitation mechanism is described. The results allow information on optimum conditions of operation to be given. (auth)

19214 TRACK DIAMETER DISTRIBUTION OF SPONTANEOUS FISSION FRAGMENTS OF ^{244}Cm ON SILICEOUS GLASS SURFACE. Gorshkov, V. K.; L'vov, L. N.; Khrudeva, G. A. At. Energ. (USSR); 28: 73-5(Jan 1970). (In Russian).

Studies were made of the distribution of fission fragments from the spontaneous fission of ^{244}Cm. An isotope in oxide form with the thickness not exceeding 1 $\mu g/cm^2$ was coated on an aluminum layer and the craters were studied with an MBI-3 microscope. The distribution of ^{244}Cm fission fragments along the crater diameter on a silicate glass was studied as a function of the thickness of the absorber using the air, at normal pressure and temperature, as a fission fragment moderator. The scheme of the experiment and the curves obtained are included. (R.V.J.)

19215 SCINTILLATION TYPE GAMMA-RAY DOSIMETER WITH LOW SENSITIVITY TO FAST NEUTRONS. Schneider-Kuehnle, P. (Christian Albrechts-Univ., Kiel). Atomkernenergie; 15: 81(1970).

In neutron spectroscopy with organic scintillators, pulses due to gamma radiation are discriminated by an electronic analysis of the pulse shape. Instead of suppressing the gamma radiation the discriminating electronic device can be used to measure the neutron spectrum and the dose in air simultaneously. The basic equations and the characteristics of such a system are discussed. (W.H.K.)

19216 COLLIMATOR CHARACTERISTICS FOR RADIOISOTOPE SCANNING. Tsialas, Stergios P.; Hine, Gerald J. (International Atomic Energy Agency, Vienna). J. Nucl. Med.; 11: 100-6(Mar 1970).

The physical properties of a collimator-detector system for rectilinear scanning are described by its spatial resolution, its plane-source sensitivity and its septum penetration. These three parameters depend on the design and dimensions of the collimator, the energy of the gamma rays employed, and the properties of the detection system. For a particular gamma-ray emitter, the three collimator parameters can be determined from scans of a line source in air. A knowledge of these parameters is indispensable for the selection and best use of a collimator for a particular scanning application. Special attention must be given to the variation of collimator resolution with distance from the face of the collimator. Values for the three parameters have been determined for 18 collimators from three manufacturers. (auth)

19217 MULTICHANNEL PULSE-HEIGHT ANALYZER AS RECORDING DEVICE OF WIRE SPARK CHAMBER. Kobayashi, Masaaki; Kondo, Kuintaka; Nishikawa, Tetsuji; Yoshida, Hajime (Tokyo Univ.). Jap. J. Appl. Phys.; 9: 323-6(Mar 1970).

PHA in a multiscaler mode was used successfully as a recording device of a wire spark chamber in the polarization measurement of bremsstrahlung by which the angular distribution of symmetric electron-positron pairs was observed. For every event, the spark positions are written in ferrite memory cores and read out at a rate of 3 μsec per wire. A logic system classifies the event into one of the four categories; miss, single, double and error events and the spark location is stored in a binary counter for the single and the double ones. Then the event is stored into a corresponding channel of PHA by using a dwell advance pulse train of 10 kHz and a store pulse. Use of PHA has been developed as a simple recording system of spark wire chamber in comparison with an on-line computer system, when only a simple logic is applied. Anomaly of the chamber or the beam is also easily detected in the angular distribution on the scope of PHA. (auth)

19218 STATIC GAMMA BACKGROUND MONITOR FOR IDENTIFICATION OF CONTAMINATION AND DOSE-RATE IN THE CASE OF DISPERSAL RADIONUCLIDES TO THE ATMOSPHERE. Pensko, Jerzy; Jagielak, Jan (Central Lab. for Radiological Protection, Warsaw). Nukleonika; 14: 831-42 (1969).

The construction of a static scintillation gamma background monitor and method of measurement, which could be used for identification of environmental radioactive contamination in atmosphere and soil, is described. The dose-rate of environmental gamma radiation could be continuously measured and the increase of the dose-rate of about 10 per cent could be detected. This method should be useful in the emergency associated with the uncontrolled dispersal of radionuclides to the atmosphere. (auth)

19219 TOMOGRAPHIC RADIOACTIVITY SCANNER WITH SIMULTANEOUS READOUT OF SEVERAL PLANES. Anger, Hal Oscar. British Patent 1,184,304. 11 Mar 1970. Priority date 15 Jun 1967, United States.

A radioisotope scanner system is described which simultaneously obtains multiple images focused at different planes or levels in the subject. These multiple readouts can be modified and combined to provide a preferential focusing effect on radiation sources located on a selected plane in the subject. (W.H.K.)

19220 PHOTOGRAPHIC COMPOSITIONS AND PROCESSES. Fotland, Richard A. (to Horizons Inc.). British Patent 1,180,883. 11 Feb 1970. Priority date 22 Sep 1967, United States.

Non-silver photographic compositions for producing images under the action of radiation having wavelengths shorter than 400 millimicrons such as uv, x rays, gamma rays, electrons, alpha particles, and protons are described. The composition is composed of colorless leuca compounds, halogen-containing compounds, and a polymer. (W.H.K.)

19221 SCINTICAMERA. Ueyanagi, Hideo; Kinoshita, Katsuhiro; Omae, Sakae (Shimadzu Seisakusho Ltd., Kyoto). Shimazu Hyoron; 26: 423-37(Dec 1969). (In Japanese).

The history, principles, and some fundamental features and applications of a scinticamera for use in nuclear medicine are discussed. Also, some detailed discussions on operational features of Nuclear Chicago's Scinticamera PHO/GAMMA III and Positron-camera Positron III are presented. (auth) (NSA of Japan)

19222 SCINTISCANNER. Nakanishi, Shigemasa; Toda, Masayoshi; Maruoka, Fumio (Shimadzu Seisakusho Ltd., Kyoto). Shimazu Hyoron; 26: 439-50(Dec 1969). (In Japanese).

The Shimadzu scintiscanner which is most widely used in the field of nuclear medicine is described. The history of its development at Shimadzu Seisakusho Ltd., and the features of the newest model including the design philosophy and construction are discussed. (auth) (NSA of Japan)

19223 LARGE AREA PROPORTIONAL COUNTER FOR ASSESSMENT OF PLUTONIUM LUNG BURDEN. Tomitani, T.; Tanaka, E. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 18: 195-206(Mar 1970).

The detector system consists of two large area proportional detectors of the same size, each of which consists of twin main counters surrounded by built-in guard counters acting also in the proportional region and in anti-coincidence with the main counters. In order to reduce secondary electrons and β-rays from the subject, front guard counters are also arranged at the side of the entrance window relative to the main counters. Main counters are separated from guard counters by a multi-wire cathode to eliminate wall effect by reducing net wall area exposed to the main counters. Main counters, which are provided with field tubes in order to correct electric field distortion near the end of the counters, exhibit excellent uniformity of efficiency distribution and gas gain distribution over the entire volume of the sensitive region defined by the field tubes. As a consequence, good energy resolution is achieved, for example, 12.6% F.W.H.M. for 13.6 keV L-X rays of ^{239}Pu. A multi-wire cathode results in imperfect electrostatic shielding, which allows electrostatic interaction between main counters and guard counters, and variation of effective volume and gas gain depending on the anode potential of the guard counters. Calculation of potential distribution near the cathode wire revealed that the interval of the cathode wire should be less than about 3 mm, and some experimental results are also presented. The background of this detector with a gas filling of 90% argon plus 10% methane at 1 atm was 199 counts/min without anti-coincidence and 13.8 counts/min with anti-coincidence in an ordinary laboratory, and 73.0 counts/min without anti-coincidence and 1.46 counts/min with anti-coincidence inside an iron room. Preliminary calibration of the detector efficiency indicates the possibility of detecting about half of the maximum permissible plutonium lung burden in 100 min counting time. (auth) (UK)

19224 A COMPACT COUNTING SYSTEM UTILIZING INTEGRATED CIRCUITS AND A SOLID STATE DETECTOR. Chester, J.; Chase, R. (Brookhaven National Lab., Upton, N. Y.). Health Phys.; 18: 191-4(Mar 1970).

A counting system for determining the activity of α-contaminated smears was designed and built utilizing integrated circuits and a silicon surface-barrier detector. The use of integrated circuits makes it possible for the complete system, including the detector, timer, scaler and readout, to be contained in a double-width AEC standard Nuclear Instrument Module. This permits five alpha smear-counting systems to fit into the space required for one conventional scaler. The 350 mm^2 detectors provide a counting efficiency of 25% for a 110 mm^2 sample. The 24-V bias required for the detector is readily available from the NIM Bin power supply and no external high voltage supply is required. Timing is provided by

scaling clock pulses from a unijunction transistor oscillator and counting times from 0.1 min to 80 min may be selected on the front panel. Scaling of the clock and detector pulses is accomplished by using a binary coded decimal decade counter. The output of the detector counter is displayed on NIXI tubes. Half inch NIXI tubes are used which facilitates fitting three decades in a double-width module. The units have proved successful during the first year of operation as demonstrated by their continued reliability and high degree of user acceptance. (auth) (UK)

19225 THERMAL NEUTRON SURVEY METER (24 Feb 1970) (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1973).

12 drawings.

This meter is a slightly modified and repackaged Q-2004 thermal-neutron survey meter (see CAPE-745). The chassis measures $7\frac{1}{2}$ by $3\frac{11}{16}$ by $2\frac{3}{4}$ in. and weighs two lbs. Charge sensitivity is one $V/2.5 \times 10^{-13}C$. A BF_3 proportional chamber is employed with the meter. The BF_3 chamber is encased in a cylindrical Cd-plated high-density polyethylene moderator. A transistorized-regulated h-v power supply is used with the meter. (For details see TID-4100 Suppl. 57) (F.S.)

19226 WHOLE-BODY-COUNTER PALLET DRIVE (27 Feb 1970) (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE-1976).

3 drawings.

The drive adjusts the speed and travel distance of the pallet of a shadow-shield whole-body counter. An arrangement of mechanical linkages is adjusted according to the height of the person being measured, to position two threaded bearings on threaded shafts. The drive permits accurate speed control under conditions of varying pallet load, friction, and leveling. (For details see TID-4100 Suppl. 57) (F.S.)

19227 MECHANISM OF ENERGY TRANSFER IN LIQUID SCINTILLATORS CONSISTING OF A SOLVENT, TWO SOLUTES, AND A TRANSPARENT QUENCHER. Germai, G. (Univ., Liege). Radiochem. Radioanal. Lett.; 3: 183-91(28 Mar 1970). (In French).

Among various problems concerning radiation measurements, the energy transferring mechanism in liquid scintillators including one solvent, two solutes, and one transparent quencher, has not been studied theoretically. Many experiments show that the quenching law is still linear and that the quenching constant is independent from the secondary solute concentration. An energy transferring mechanism is proposed from which transfers from solvent to secondary solute and external quenching of the primary and secondary solutes are missing. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstract 20401.

19228 (CTC-25) RESAP: A PROGRAM FOR THE LEAST SQUARES ANALYSIS OF GAMMA SPECTRA INVOLVING INTERMIXED STANDARD SAMPLES. Brooks, A. A.; Hume, A.; Handley, B. J. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 19 Mar 1970. Contract W-7405-eng-26. 76p. Dep. CFSTI.

The Radiation Ecology Spectra Analysis Program, RESAP, was written to provide for a linear least squares analysis of data obtained from unknown samples, standard samples and background samples which were run in an intermixed fashion. The program, while not providing any new analytical procedures, has been implemented in a fashion to provide for (1) a variety of input situations, (2) a choice of background treatment, (3) a criteria for channel elimination, (4) a rejection of non-significant parameters, (5) the correction for decay of radioactive species, (6) the pooling of replicates, and (7) the rejection of spectra. The program assumes a linear model for the counts integrated over the counting interval and relates the concentrations back to a zero time. Dual detectors are corrected for gain shift and the dual counts are summed and treated as one response. A brief discussion of the method is given, followed by a description of input and program options. The program listings are given followed by sample data sheets and sample test cases. (auth)

19229 (DP-1212) IC DIGITAL DATA SYSTEM FOR MOESSBAUER SPECTROSCOPY. Byrd, Joseph S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan 1970. Contract AT(07-2)-1. 22p. Dep. CFSTI.

A fast multichannel scaler with integrated digital control circuits and a 512-word ferrite-core memory was designed to collect and to store data for Moessbauer spectroscopy. System dead time is 2 microseconds. The data spectrum with up to 4.2 billion counts per channel can be displayed on an oscilloscope and punched on computer cards. Variable mode addressing allows forward and backward scanning. (auth)

19230 APPLICATION OF COMPUTERS IN THE ANALYSIS OF GAMMA SPECTRA. Hrabovcova, Alojzia (Research Inst. for Work-Hygiene and Occupational Diseases, Bratislava). Jad. Energ., 16: 37-41(Jan 1970). (In Czech).

A review on the principles of several analytical methods for computer analysis of complex gamma spectra obtained from NaI/Tl-scintillation and Ge/Li-semiconductor spectrometers is presented. (23 references) (auth)

19231 DETECTION OF ELECTRONS BY SURFACE-BARRIER SILICON DETECTORS AGAINST BACKGROUND OF GAMMA-RAYS OF COMPARABLE ENERGY. Maksimenko, B. P.; Bezmel'nitsyn, V. N.; Mitin, A. A. At. Energ. (USSR); 28: 71-3(Jan 1970). (In Russian).

A surface-barrier silicon counter with a 40 × 40 mm NaI(Tl) crystal was used for spectrometric studies of electrons using a ^{51}Co source emitting 14, 122, and 136 keV γ quanta and electrons of internal conversion with 115 and 129 keV energies. The results showed the counter was effective in recording the electrons under conditions of a strong background field of γ radiation. (R.V.J.)

19232 NEW ABSOLUTE DETERMINATIONS OF ALPHA-PARTICLE ENERGIES. Grennberg, Bertil; Rytz, Albrecht (Bureau International des Poids et Mesures, Hauts-de-Seine, France). Compt. Rend., Ser. B; 269: 652-4(6 Oct 1969). (In French).

It is proposed to determine with the greatest possible precision a certain number of alpha particle energies, in order that they may serve as standards. For this purpose a recently constructed magnetic spectrograph designed for absolute measurements of alpha particle energies is used. The first results, referring to ^{212}Bi(ThC), are shown in a table. (J.F.P.)

19233 A NEW NEUTRON CRYSTAL SPECTROMETER OF HIGH RESOLUTION AND ITS APPLICATION. Alefeld, B.; Birr, M.; Heidemann, A. (Munich Inst. of Tech.). Naturwissenschaften; 56: 410-12(Aug 1969). (In German).

The paper consists of 3 parts: I. A neutron crystal spectrometer with extremely high resolution. (Alefield, Birr, Heidemann). It describes the instrumentation through which the relatively low energy resolving power of customary neutron crystal spectrometers ($\Delta E/E$) up to 0.5×10^{-2} can be improved by 2 orders of magnitude. It is based on the fact that a monochromatic neutron beam, obtained by reflection on mono-crystals at a backscattering angle near 90°, have an extremely small line width of the reflected beam. At this angle the primary extinction determines the resolution. If the "white" neutron beam of a reactor is monochromatically reflected by the (1,1,1)-grating of a single Si crystal and directed through a concave mirror of 1900 Si crystals toward the target, located in the curvature center and cooled by a N-cryostat, then about 3.0% of the incoherently scattered neutrons can be counted by a BF_3-counter. The energy analysis of the scattered neutrons is done through a Doppler movement of the monochromator crystal in combination with a chopper that interrupts the primary beam. The resolution was determined with a V monocrystal at about 6×10^{-4} to 1×10^{-7} eV. II. Inelastic spin-flip scattering of vanadiumtrioxide (Heidemann). The described spectrometer was used to measure the energy spectrum of neutrons scattered by V_2O_3 in a magnetic field for 3 reasons: (a) The spin-coherent scatter cross section of V is large (5.03 barns). (b) The energy level distance produced by an internal magnetic field lies between 0.2 and 2.0 μ eV. (c) Various measurements on V_2O_3 gave contradictory answers to the question whether V contains an inner magnetic field at T < 150°K. For the first time it was possible to demonstrate the inelastic spin-flip-flop of neutrons scattered by the V nucleus. It was found that V_2O_3 has at 105°K a magnetically ordered configuration. From the magnitude of the magnetic cleavage an internal magnetic field of (175 ± 15) KOe could be calculated. III. Quasi-elastic neutron scattering on glycerine (Birr). The neutron back-scattering spectrometer allows the measurement of the broadening of the quasi-elastic peaks in the energy spectrum of liquids which is a function of temperature. This function characterizes the diffusion mechanism of a molecular liquid. Since glycerine has a highly temperature dependent viscosity and water content, a relatively large range of changes in the width of inelastic peaks could be covered. Measurements were made on a 1.4 mm thick sample (water content 2 and 13%) between 183 and 296°K. The relation between peak broadening E and diffusion constant allows to calculate the latter. The obtained value is in agreement with the diffusion constant calculated from viscosity values according to the Eyring formula. (F.J.W.)

19234 IMPROVEMENTS IN OR RELATING TO LIQUID SCINTILLATION SPECTROMETRY. (to Packard Instrument Co. Inc.). British Patent 1,185,072. 18 Mar 1970. Priority date 11 Apr 1966, United States.

An external standard source array and transfer mechanism for positioning the entire array alternately in a first operative position adjacent but external to a sample including a radioactive isotope and a second inoperative position remote from the sample is described. The array comprises two external standard radioactive sources having known but different emission characteristics and a spacer for maintaining said sources in a fixed separated relation. The transfer mechanism is adapted to shift the array between the first operative position with both sources adjacent but external to a sample and a second inoperative position with both sources remote from the sample. (W.H.K.)

19235 STUDY OF INSTRUMENTATION FOR MOESSBAUER EFFECT. Niki, Eiji; Watanabe, Noriyuki (Tokyo Univ.). Tokyo Daigaku Kogakubu Kiyo, A; No. 7, 56-7(Dec 1969). (In Japanese).

A stable, high-fidelity velocity spectrometer for studying the Moessbauer effect has been developed by making use of the electromechanical feedback system, with 12.5 H_2 saw tooth wave as reference signal. Isomer shift can be determined with a good reproducibility of ±0.02 mm/sec. The velocity range is continuously variable from ±2 mm/sec to ±5 mm/sec at full scale and can be expanded for the other purpose. (auth) (NSA of Japan)

19236 MULTI-PURPOSE MANUALLY OPERATED NEUTRON CRYSTAL SPECTROMETER. Alston, W. C. H.; Jones, T. C. (London Univ.). J. Phys., E (London); 3: 265-7(Apr 1970).

The design of a neutron spectrometer capable of performing a number of experiments is described. Rocking curve measurements using two different crystal-to-detector resolutions are shown as well as a typical count-rate spectrum. (auth) (UK)

High Energy Physics Instrumentation

Refer also to abstract 19792.

19237 (IS-2228) AMES LABORATORY ON-LINE CONTROL SYSTEM FOR BUBBLE CHAMBER FILM MEASURING. Higby, W. J.; Klein, A. H. (Ames Lab., Iowa). Dec 1969. Contract W-7405-eng-82. 33p. Dep. CFSTI.

The bubble chamber film measuring control system used at Iowa State University is described. The main features of the system provide for complete flexibility of control criteria used for a given experiment. The syntax of the KERTRAN language is given with examples of how it is used for control purposes. (auth)

19238 (IS-2229) KUBER: THE CONTROL PROGRAM FOR THE USAEC AMES LABORATORY ON-LINE MEASURING SYSTEM. Klein, A. H.; Higby, W. J. (Ames Lab., Iowa). Dec 1969. Contract W-7405-eng-82. 42p. Dep. CFSTI.

A program called KUBER has been written to provide control for an on-line measuring machine system for bubble chamber events. The program interprets a table of task words for each measuring machine and performs the tasks specified. It supervises the input of data from the measuring machines and calls routines to process the data. (auth)

19239 MICROPHOTOMETERING OF PARTICLE TRACKS ON PHOTOS OF HYDROGEN BUBBLE CHAMBER. Dasaeva, M. A.; Melikova, A. G.; Salukvadze, R. G.; Tuliani, I. I.; Shoshiashvili, Sh. S. (Tbilisi State Univ., USSR). Soobshch. Akad. Nauk Gruz. SSR; 53: 541-4(Dec 1969). (In Russian).

Ionization measurements are often required for identification of particles on photos obtained in track devices. The technique of microphotometering is used to measure relative blackening of particle tracks on photos obtained by means of a hydrogen bubble chamber. Calculated graphs of relative blackening dependence on momentum of different particles are plotted. The results of the measurements are compared with the theoretical values. There is a reasonable agreement. On the basis of the technique worked out, a program for identification of particle tracks is compiled for the computer. (auth)

19240 SPARK CHAMBER READER SYSTEM (11 Feb 1965) (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). CAPE-1969).

40 drawings.

The automated reader system optically scans data recorded at a spark chamber on 35-mm film. Two scanning positions are incorporated— one produces a normal scan and the other an orthogonal scan. Sixteen lenses, which are mounted in a rotating wheel, are employed in scanning. As each lens passes across a cone of light, a light spot is generated that sweeps across the film. The light passes through the film and is monitored by a photomultiplier tube at both the normal and orthogonal windows for the determination of data points. A data level control compensates for different grades of film. (For details see TID-4100 Suppl. 57) (See also 21: 3239) (F.S.)

Radiation Dosimeters

Refer also to abstracts 19215 and 19325.

19241 (ANL-Trans-814) EFFECT OF HEAT TREATMENT ON THE THERMOLUMINESCENCE OF LITHIUM FLUORIDE. Grube, M. M.; Grant, Z. A. Translated for Argonne National Lab., Ill., from Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser.; No. 6, 40-4(1968). 7p. Dep. CFSTI.

Experimental results on the effect of heat treating conditions on the thermoluminescent decay curve of lithium fluoride are presented. A heat treating process is proposed which permits the repeated use of thermoluminescent detectors and requires only 7 to 15 minutes treatment time. (W.H.K.)

19242 (MIT-952-6, pp 133-54) DOSIMETRY. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

The development of thermo-stimulated exo-electron emission (TSEE) detectors is summarized. A special gas flow GM detector was used to detect the low energy exo-electrons for various materials, primarily $BaSO_4$ and $SrSO_4$. Total TSEE counts as a function of dose after alpha, beta and neutron irradiation are graphed. Also, the theory of thick source alpha spectrometry is discussed. The method of derivation of the range and energy spectra for a thick alpha source is presented for the one-medium case and the two-medium case. (W.H.K.)

19243 (NYO-3409-8) ROLE OF TRAPPING PROCESSES IN SOLID STATE RADIATION DOSIMETRY. Progress Report, 1969/1970. (Pennsylvania State Univ., University Park. Materials Research Lab.). Feb 1970. Contract AT(30-1)-3409. 27p. Dep. CFSTI.

A study on the use of electrets for dosimetry of uv radiation is described. Preparation of the electrets is discussed, and the readout method, which includes heating and monitoring the output voltages and currents, is described. Both pyroelectric polarization and field-induced polarization are studied. Doped and undoped zinc sulfide single crystals and powder samples were studied. Also, the thermoluminescence properties of boron nitride hot-pressed powder were investigated for their possible use for x-ray dosimetry. (W.H.K.)

19244 EFFECTS OF ATMOSPHERE AND GRAIN SIZE ON THERMOLUMINESCENCE SENSITIVITY OF ANNEALED LiF CRYSTALS. Nakajima, T. (National Inst. of Radiological Sciences, Chiba, Japan). J. Phys., D (London); 3: 300-7(Mar 1970).

A study has been made on the thermoluminescence sensitivity of lithium fluoride crystals as a function of both grain size and the surrounding atmosphere when given prolonged annealing at high temperatures. Optical grade lithium fluoride and dosimetry grade lithium fluoride (Harshaw TLD-100) do not show the same response to high-temperature annealing. For a given technique of quenching from high temperature, the thermoluminescence sensitivity of optical grade lithium fluoride increases with temperature when annealed in the absence of air, whereas the thermoluminescence sensitivity of TLD-100 stays roughly constant. When annealed in air the sensitivity of TLD-100 decreases sharply with increasing temperature. Optical grade crystals when annealed in air show an increase in optical absorption in the visible spectrum, and infra-red absorption bands are found due to the presence of OH anions which are a known thermoluminescence poison. Optical grade crystals show a generally decreasing sensitivity with increasing grain size. (auth) (UK)

19245 THERMOLUMINESCENCE DOSEMETER. Szymczyk, W.; Siuda, J.; Drejak, Z. (Inst. of Oncology, Krakow). Pol. Przegl. Radiol. Med. Nukl.; 33: 813-20(1969). (In Polish).

A dosimeter is described based on the thermoluminescence principle. The equipment is utilized in the Oncological Institute in Krakow. The properties of lithium fluoride with luminescence maximum at 120°C are described. (auth)

19246 UTILIZATION OF POLYMER-GELATIN NUCLEAR EMULSIONS FOR FAST NEUTRON DOSIMETRY. Nikodemova, Denisa (Research Inst. for Work-Hygiene and Occupational Diseases, Bratislava); Mancova, Valeria; Bradna, Frantisek. Jad. Energ.; 16: 48-52(Jan 1970). (In Czech).

The results and characteristics of fast neutron dosimetric measurements are discussed, using the new type of sensitive polymergelatine nuclear emulsions. Furthermore, the calibration with four neutron sources, processing, as well as the limitations of using these nuclear emulsions are described. Measurements on the phantom and the direction dependence were made. The number of proton tracks as a function of dose equivalent for the generally used neutron sources was investigated and compared with theoretical calculations of the doses. (auth)

19247 ESOPHAGEAL DOSE ESTIMATIONS UTILIZING THE THERMOLUMINESCENCE METHOD IN ROTATION RADIOTHERAPY. Szymczyk, Wislawa; Siuda, Jerzy; Kujawska, Janina; Skolyszewski, Jan (Inst. of Oncology, Krakow). Pol. Przegl. Radiol. Med. Nukl.; 33: 821-5(1969). (In Polish).

The dose distribution in the esophagus was estimated utilizing the thermoluminescence technique. The measurements were performed during rotation radiotherapy of this organ. The results indicate the necessity of verification of the esophagus situation in relation to the therapeutic beam and repeated dose measurements in the course of one month lasting treatment. The conformity of the locally found doses, with those calculated from effective contour technique was stated. (auth)

19248 CHEMILUMINESCENCE IN DOSIMETRY. Kubal, J. (Inst. of Nuclear Science, Prague). Arh. Hig. Rada Toksikol.; 20: 131-41(1969). (In Czech).

Trace amounts of H_2O_2 that form as a result of radiolytic decomposition can be determined on the basis of chemiluminescence emitted in the oxidation of luminol. A sensitive apparatus for measurement of this chemiluminescence has been developed in which a USSR photomultiplier FEU 19 M with a spectral sensitivity covering the range of emission of luminol serves as detector. As catalysts of the chemiluminescence reaction Fe^{3+} salts were found unsuitable because of the emission caused by them in the absence of H_2O_2 and Cu^{++} salts because of their short-lived effect. Hemin added in the form of a solution proved to be a suitable catalyst. Addition of a complex formed by Cu^{++} with triethanolamine stabilized the effect produced by hemin. The lower threshold of sensitivity of determinations by the method developed was a 2×10^{-6} M concentration of H_2O_2. At low concentrations of H_2O_2, the intensity of the light emitted increased linearly with the concentration of H_2O_2. (18 references) (JPRS)

19249 A SIMPLE PHOTOGRAPHIC FILM DOSIMETER OF LOW ENERGY DEPENDENCE. Tait, G. W. C. Health Phys.; 18: 289-93(Mar 1970).

A major weakness of photographic film dosimetry has been the large energy dependence for X-ray energies of most common medical application and the errors that occur when attempting to measure mixed radiation containing appreciable low energy X-ray components. Gamma radiation and high energy X-radiation above 300 keV can be evaluated photographically by an energy independent calibration provided the beam is filtered to remove any less energetic radiation to which the emulsion shows an enhanced response. At the other end of the energy spectrum a considerable range of biologically significant radiation can be evaluated with a calibration appropriate to the film response to X-rays of quantum energy giving peak photographic response, and available data show that in this way narrow band radiation from 20 to 70 keV can be measured within 20% and X-rays from typical medical installations with a broad energy spectrum with even less error within this energy range. The critical problem is the evaluation of X- and γ-radiation in the quantum energy range 70 to 300 keV. A method was sought to fit together the response curves in such a way that the error in evaluating dose in the intermediate region is an acceptable minimum, and the monitoring method described is stated to show better freedom from energy dependent errors than previous methods. It is also free from the errors that occur when monitoring electromagnetic radiation from a combination of sources. The method is based on the fact that the physical processes by which a filter absorbs radiation are the same as those which determine the linear density of response in emulsion material. A simple film holder with an open window plus a single filter of 1.5 mm Ag is the only special requirement. The calibration standards are prepared in a similar way to those required for previous methods, although the calculations are different in principle. The evaluation technique is suitable for large scale use by semi-skilled personnel, and the method would appear to have particular application to national film monitoring services. Some experimental tests of the method are described. (UK)

19250 FESTKOERPERDOSIMETRIE IONISIERENDER STRAHLUNG. (Solid-State Dosimetry of Ionizing Radiation). Frank, Manfred; Stolz, Werner. Leipzig; BSB B. G. Teubner Verlagsgesellschaft (1969). 283p. 39,- M.

The theory and operation of solid-state detectors for radiation dosimetry are described. Detectors for integral dose measurements including thermoluminescent, radiophotoluminescent, exoelectron emission, glass and plastic colorimetric, and particle track detectors are discussed. Also, dosimetry using solid-state scintillation detectors and semiconductor detectors is described. (W.H.K.)

19251 A TSEE G-M GASFLOW COUNTER. Oberhofer, M.; Robinson, E. M. (Oak Ridge National Lab., Tenn.). Kerntechnik; 12: 34-8(Jan 1970).

The thermally stimulated exoelectron emission (TSEE) from the surface of many materials, mostly ionic crystals like CaF_2, LiF and BeO are made use of more and more for dosimetric purposes. TSEE curves are obtained by heating up the samples of interest and measuring the exoelectron emission as a function of sample (surface) temperature. A TSEE counter with its accessory instrumentation is described which allows TSEE materials to be heated linearly with heating rates from 0,5 to 10 K/s up to a maximum temperature of 700°C. (auth)

Radiometric Instruments

Refer also to abstracts 19085 and 19087.

19252 DETERMINATION OF THE MINIMAL DIMENSIONS OF MODELS FOR GAMMA-GAMMA MEASUREMENTS. Charbucinski, Jacek; Umiastowski, Krzysztof (Inst. of Nuclear Techniques, Krakow). Nukleonika; 14: 869-83(1969).

The problem of determining the minimal dimensions of models to be used in laboratory gamma-gamma measurements is studied. The minimal dimensions of models are given for several probe lengths and for three gamma-sources (^{75}Se, ^{137}Cs and ^{60}Co). The experimental results were compared with the theoretical predictions. The results presented allow estimates of the minimal model dimensions for media of various density, for various energies of the γ-source and for various source-detector spacing. (auth)

19253 ISOTOPE METHOD FOR LIQUID SUBSTANCES MEASUREMENT IN TALL CONTAINERS. Czarnecki, Jerzy. Nukleonika; 14: 847-68(1969). (In Polish).

A new isotope method of continuous measurement of the level of liquid and granular substances, suitable especially for tall containers, is described. The method gives a linear dependence of the signal on the height of the level, and makes it possible to use a radiation source of low activity. The method consists of inserting into the space between the source and the detector a passive element-partition, which permits a gradual screening of the detector. The absorption coefficient of radiation in this method is $p = (1/1 + \mu H)$. (auth)

19254 USE OF X-RAY FLUORESCENCE ANALYSIS WITH RADIOISOTOPE FOR DETERMINATION OF CHEMICAL COMPOSITION OF ROCKS AND ORES IN MOTION. Pshenichenyi, G. A.; Ochkur, A. P.; Plotnikov, R. I.; Goganov, D. A. At. Energ. (USSR); 28: 67-8(Jan 1970). (In Russian).

Descriptions are given of the design and performance of a radioisotope x-fluorescence method for ore sample analysis on a conveyor belt. Tests were made of continuous sample control of Ti and Zr on the conveyer and compared with the laboratory data. Source of combined ^{55}Fe (5.9 keV) and ^{109}Cd (22 keV) were used for excitation of the K series of titanium (TiK_α = 4.5 keV) and zirconium (ZrK = 15.7 keV). Results obtained showed the method suitable for determining the ore content of elements with atomic number of 20 and higher, whose luminescence is sufficiently strong to penetrate 5 to 10 cm-thick air layers. (R.V.J.)

Miscellaneous Instruments and Components

Refer also to abstract 19977.

19255 (AECL-3555) RESEARCH FACILITIES AT CRNL. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb 1970. 24p. Dep. AECL.

Existing cooperation, health and safety, radiation protection, and experimental facilities including the tandem accelerator, reactor beam holes, in-core irradiation facilities, gammacell, electron microscope, Van de Graaff accelerators, mass separator, 2 MeV Febetron, and the ESR spectrometer are briefly discussed. Also, biology and health physics research, materials science, reactor physics research, and engineering test facilities are outlined. (W.H.K.)

19256 (ANL-7643) AUTOGRAPHIC DILATOMETER FOR USE WITH PYROPHORIC AND ALPHA-ACTIVE MATERIALS. Yaggee, F. L.; Styles, J. W. (Argonne National Lab., Ill.). Dec 1969. Contract W-31-109-eng-38. 19p. Dep. CFSTI.

A fused-quartz dilatometer was designed and constructed specifically for obtaining dilatation and phase-transformation data for plutonium-bearing alloys that are potential nuclear fuels. The apparatus can be installed and operated within a standard plutonium glovebox without sacrificing accuracy, sensitivity, or reproducibility in the experimental results. The dilatometer operates over the range from 25 to 1000°C, provides for programmed heating and cooling rates from $\frac{1}{2}$ to 200°C min, and will accommodate cylindrical, tubular, or sheet specimens that are from $\frac{1}{4}$ to $\frac{2}{3}$ in. in diameter (or width) and $\frac{1}{4}$ to 2 in. in length. Dilatation runs can be made in vacuum (1×10^{-6} mm Hg) or in an inert gas environment of argon, helium, or nitrogen at normal glovebox pressures (≈740 mm Hg). A permanent record of the expansion versus temperature is automatically plotted. This equipment has a displacement (expansion) resolution of 2 μ in., an emf (temperature) resolution of 30 μV, and an overall reproducibility of ±0.1%. The dilatometer system can be calibrated with a Leeds and Northrup Type K-3 potentiometer. Among the unique features incorporated in the apparatus design are (1) a mechanical means of verifying the electronic output representing specimen expansion, and (2) two matched electronic gaging heads for monitoring expansion displacement. The gaging heads may be used separately to monitor free expansion as a function of specimen temperature, or simultaneously to determine the expansion interaction between two dissimilar materials that are in intimate contact (coefficient of friction nearly unity) even when the materials exhibit widely different physical, mechanical, and thermal properties. (auth)

19257 (CEA-R-3940) NEW SPECTROMETER FOR CHARGED PARTICLES. Wajsfelner, Rene (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1970. 35p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

An electrostatic spectrometer was studied and developed. It is more accurate for the determination of size distributions of electrically charged radioactive atmospheric aerosols, and can also be used for measuring the grain size distribution of any cloud of particles previously charged according to a known, reproducible law. An experimental study has been made of the development of this precipitator and of its calibration. The electrical charge on spherical polystyrene latex particles suspended in air by atomization has been studied; a theoretical explanation of these results is presented. (France)

19258 (IPP-2/74) WIDE-ANGLE MASS SPECTROMETER WITH DOUBLE DIRECTION FOCUSING. Blauth, E. W.; Weissmann, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1969. 29p. (In German). Dep. CFSTI (U. S. Sales Only).

A static wide-angle spectrometer that focuses a horizontal angle of divergence of 60° and covers a solid angle of 0.1 sterad is described. The resolution can be increased from A = 40 to A = 255 by limiting the angle of divergence. The spectrometer was fitted with an electron impact ion source with a spread of 60°. The emission yield efficiency of the source is 0.50 of the ions produced. A transmission coefficient of 0.25 is achieved with this combined electron impact and separating system. (auth)

19259 (KFK-912) DATA, AN ELECTRONIC DATA PICK UP SYSTEM. Brueckmann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Dec 1968. 19p. (In German). Dep. CFSTI (U. S. Sales Only).

A new versatile multiparameter data acquisition system designed for nuclear reaction studies is discussed. The system is in use for the investigation of three body reactions where at least two particles have to be detected in coincidence. Four analog signals which may contain information on energy loss, time of flight, or dE/dx are accepted by the system. The information is digitalized and transferred to a CDC computer. The system produces all the logical signals necessary for the common operation of the external electronic equipment. For monitoring, a separate dataway is provided. The use of the system is demonstrated by an experiment where the reaction d + d → d + p + n was studied. The applicability of the system is not restricted to this example. The high degree of flexibility permits its use for many different problems in nuclear physics. (auth)

19260 (NP-18113) REPORT FOR THE FISCAL YEAR, 1 JANUARY 1967-31 DECEMBER 1967. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 239p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

The research and development projects and administrative programs of the C.N.E.A. are briefly summarized. Publications issued during the period are listed. (C.E.S.)

19261 (RD/B/N-1320) TIME-OF-FLIGHT SPECTROMETER FOR ION COLLISION STUDIES. Woolley, R. L.; Warner, A. G.; Poole, D. H. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1970. 28p. Dep. CFSTI (U. S. Sales Only).

A description is given of equipment built to measure scattering cross sections of atom-atom collision processes in the energy range 5 to 100 keV, and the development of displacement cascades in solids, with special reference to damage cascades in reactor materials. (auth) (UK)

19262 (SC-DC-70-4747) HIGH VOLTAGE PULSE MEASURING SYSTEM. Wunsch, D. C. (Braddock, Dunn, and McDonald, Inc., Albuquerque, N. Mex.); Booker, S. R. (Sandia Corp., Albuquerque, N. Mex.). [13 Mar 1970]. 18p. (CONF-700302-2). Dep. CFSTI.

From Instrumentation for Nuclear Weapon Effects Symposium, Albuquerque, N. Mex.

A system to measure high voltage pulses with very high resolution is described. The system is based on a unique application of the electro-optic Kerr effect and measures voltage pulses with magnitudes from 10^4 to 3×10^5 V. The system has a linear frequency response to approximately 100 MHz. Unlike the resolution of other voltage-measuring systems, the resolution of this system increases as the voltage pulse increases toward its peak value. The peak pulse magnitude can be measured with a resolution of better than 0.1%. The system can be calibrated so that the measured value of the peak voltage is accurate to within ±1% of the true value. This high resolution is obtained by modulation of a constant intensity light source by action of a Kerr cell. The electric field intensity resulting from the high voltage pulse causes phase differences as great as 25 π radians between light components in the Kerr cell. Consequently, many light cycles are obtained during the voltage rise of the pulse. This produces extreme resolution near the peak of the pulse. Near the peak, a 2% change in voltage results in a 100% change in light intensity. Accurate pulse voltage measurement techniques are useful in several areas of weapon effects testing. Direct measurement of EMP levels in simulators are desired. The fundamental techniques described can be used for such measurements. Accurate measurement of single high voltage transients for component and circuit testing can also be made. The technique is also useful for diagnostic measurements on other weapon effect simulators such as the measurement of tube voltages on x-ray and neutron generators. (auth)

19263 (TID-25366) THREE-WIRE INSULATOR-SHUNTING MODEL FOR HIGH-TEMPERATURE THERMOCOUPLE ERRORS. McDearman, J. R.; Googe, J. M. (Tennessee Univ., Knoxville. Dept. of Electrical Engineering). 1 Dec 1969. 27p. Dep. CFSTI.

An equivalent circuit and computer solution were formulated for describing the output of a metal-sheathed, bifilar thermocouple degraded by insulator shunting at high temperatures. This steady-state equivalent circuit model can be used for prediction of errors in thermocouple calibrations, for examining the effects of changes in thermocouple configuration or materials properties, and for examining methods for interrogation or surveillance of the shunting thermocouples. (auth)

19264 (UCRL-50761) EFFECTS OF SPACE CHARGE, ANODE FIELD, AND INITIAL ELECTRON VELOCITIES ON THE SATURATION CURRENT IN A CROSSED-FIELD PHOTOMULTIPLIER TUBE. Bevensee, Robert M. (California Univ., Livermore. Lawrence Radiation Lab.). 6 Jan 1970. 22p. Dep. CFSTI.

A model of a practical crossed-field photomultiplier tube is analyzed for the dependence of the tube's saturation current density on the focussing dc fields, the spacing between the cathode and the repeller, the transverse electric field of the anode, and the initial electron velocity normal to the cathode. The effect of space charge on potential distribution but not on electron trajectories is included. Three cases are discussed—that of no anode field and no initial electron velocity, that of a constant or linear anode field and no initial electron velocity, and that of no anode field but an initial electron velocity. The results of this analysis are presented as a set of curves of normalized saturation current density versus y_m/h, where y_m is the height to which the electrons rise in their cycloidal motion and h is the cathode-to-repeller spacing. The various curves are distinguished by different values of the parameters that measure the anode field or the initial electron velocity. It is concluded that a photomultiplier tube should be operated with as large a magnetic field for a given repeller voltage and geometry as is practical in order to

maximize the saturation current density, which the actual current density would approach in a real tube. Furthermore, both the anode field and the initial electron velocity tend to increase the saturation current density. (auth)

19265 GAIN DEGRADATION OF LEAD-TYPE CHANNEL ELECTRON MULTIPLIERS IN ULTRAHIGH VACUUM. Bennett, F. D. G.; Thorpe, D. G. (SRC Radio and Space Research Station, Slough, Eng.). J. Phys., E (London); 3: 241-3(Mar 1970).

Grain degradation measurements have been carried out on five 419BL and two 318BL Mullard lead-type channel electron multipliers, over periods up to several thousand hours, at a pressure of less than 10 ntorr. The devices showed reductions of about one order of magnitude on their initial gain values. The reduction occurred in 10 h at an output count rate of 2×10^5 counts s^{-1} and several thousand hours at 2×10^2 counts s^{-1}. At the high output count rate, the initial gain was found to be depressed by over an order of magnitude on the nominal value of 10^8. (auth) (UK)

19266 METHOD OF IMPROVING SENSTITIVITY AND RESOLUTION OF A MASS SPECTROMETER. Futrell, Jean H.; Abramson, Fred P.; Miller, Carroll D. (to Secretary of the Air Force). U. S. Patent 3,487,208. 30 Dec 1969. Filed 1 Jun 1967.

A variable focus electrostatic lens is located between the electric sector and the object slit of the source lens assembly of a double focusing mass spectrometer, and is attached to the electric sector field termination shunt. Focusing plate electrodes providing an aperture of predetermined size are affixed between the object slit and the spectrometer ion source chamber. A common adjustable accelerating voltage power supply is in the circuit with the focusing plate electrodes to control the acceleration and focusing of ions ejected from the ion source chamber on the object slit, and, in addition, both activate and provide a variable focusing action of the electrostatic lens to shift the apparent object plane in accordance with a variation in current intensity and correct for image errors at the geometric object slit. (Offic. Gaz.)

19267 LIQUID METAL SAMPLING APPARATUS. Ilincev, Georgi; Krupicka, Petr; Janca, Josef (State Research Inst. for the Protection of Materials, Prague). Jad. Energ.; 16: 59-61 (Jan 1970). (In Czech).

A description of an apparatus for taking samples of liquid alkali metals and alloys and depositing them in glass ampules, then sealing them in a vacuum or in an inert atmosphere is given. The apparatus has been applied for taking sodium samples during the operation of loops up to 800°C. The samples have been taken mainly for the determination of carbon content and form in sodium, and for the determination of hydrogen. (auth)

19268 SENSITIVE HIGH VACUUM GAUGE USING AN ELECTRON MULTIPLIER. Windsor, E. E. (Mullard Research Labs., Redhill, Eng.). Vacuum; 20: 7-9(Jan 1970).

In the conventional Bayard–Alpert ion gage undesirable interactions occur between the gage and its environment due to the pumping action which is inherent in the operation of the gage, and to the desorption and dissociation of gas by heated components. These effects can be minimized by using an electron multiplier as an ion detector and amplifier, and the necessary small ionizing current can be provided by a cold emitter. A practical form of gage having a digital output and providing a linear response to pressure changes over three orders of magnitude is described. (auth) (UK)

19269 PHOTOMULTIPLIERS AND THE TRANSFER TECHNIQUE. Nussli, J. Philips Tech. Rev.; 30: 236-40(1969).

When the transfer technique for activating photocathodes is applied to photomultipliers of conventional design, there is a considerable improvement in their noise characteristics and, in certain cases, in their sensitivity. This new technique also makes it possible to develop new types of tube such as the "hybrid" photomultiplier, in which the multiplier is in fact a semiconductor electron detector (the electrons being accelerated to an energy ranging from 10 to 40 keV), or the microchannel photomultiplier, which includes an arrangement of channel electron multipliers. The hybrid photomultiplier is less subject to statistical fluctuations in amplitude and the microchannel multiplier gives a faster response. (auth)

19270 IMPROVED URANIUM COLORIMETER (12 Sep 1967) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE–1966).

6 drawings.

This improved flow colorimeter continuously monitors liquid streams containing 0 to 10 g U per liter of solution. The analysis is correct within ±0.5 g/l. The dual-beam technique compensates for changes in light intensity caused by dirt on the optics and a highly regulated (±0.05%) 5.5 V dc power supply compensates for changes in light spectra (due to changing filament temperatures). Meter and recorder indications were made linear to read in g/l of U. The optical portion of the colorimeter can be calibrated without removing the sample cell. (For details see TID-4100 Suppl. 57) (See also 24: 2945) (F.S.)

19271 APPARATUS FOR ELIMINATING THE EFFECTS OF NOISE IN THE DETERMINATION OF NEUTRON REACTIVITY. Mayer, Walter (to Licentia Patentverwaltungs GmbH). U. S. Patent 3,499,151. 3 Mar 1970. Priority date 18 Dec 1965, Germany.

An apparatus for determining the reactivity of a material in an environment having a high noise level by detecting neutrons after they have passed through the material and by processing the detector output in an average calculator which eliminates the noise components from the detector output is described. (Offic. Gaz.)

19272 ION MICROSCOPE: THE IMAGE OF WHICH REPRESENTS THE INTENSITY OF SECONDARY RADIATION AS A FUNCTION OF THE POSITION OF THE PRIMARY IONS CAUSING THE RADIATION. Tobias, C. A. (to United States Atomic Energy Commission). U. S. Patent 3,488,494. 6 Jan 1970.

A microscope utilizing atomic or nuclear particles directed in a parallel beam through a specimen, causing secondary radiation to be emitted therefrom, is described. The position coordinates of the path of each particle are determined and the secondary radiation is measured for each particle. An enlarged image of the specimen is constructed by combining such information from many particles to form a composite image. (AEC)

19273 MEASUREMENT OF LIFE TIME OF NUCLEAR LEVEL. 1. Sakata, Akihiko; Ohira, Kyozo (Himeji Inst. of Tech., Japan). Himeji Kogyo Daigaku Kenkyu Hokoku; No. 22A: 1-5(Dec 1969). (In Japanese).

A time-to-pulse height conversion system is described which is used for measuring of life times of nuclear levels. The machine time resolution (FWHM) is less than 100 (ps) when driven by a mercury pulse generator. The physical resolution of 3.7 (ns) is found in the prompt gamma rays of ^{22}Na using as detectors NaI(Tl) scintillators and photomultipliers 56 AVP. The half life of the 81 (keV) level in ^{133}Cs is found to be $T^1/_2 = 6.23 \pm 0.17$ (ns) which is in agreement with preceding data within the experimental error. The time calibration constants are in agreement for machine time resolution curve measurements with different delay cables, physical prompt resolution curve measurements in ^{22}Na, and delayed coincidence curve measurements in ^{133}Cs. The linearity is within ~1.5 (%). (auth) (NSA of Japan)

19274 PHOTOMULTIPLIER YIELD OF A CHANNEL ELECTRON MULTIPLIER IN THE 304 TO 1493 A WAVELENGTH RANGE. Weller, C. S.; Young, J. M. (Naval Research Lab., Washington, D. C.). Appl. Opt.; 9: 505-6(Feb 1970).

The photomultiplier yield in counts per incident photon over the 304 to 1493 Å range of a Bendix Model 4039C channel electron multiplier is presented graphically. The physical characteristics and uses of the channel electron multiplier for uv detection are briefly discussed. (W.H.K.)

19275 COMMENTS ON THE OPERATION OF A PROPOSED MULTICHANNEL SPECTRAL RECORDING INSTRUMENT. Smith, D. G. (University Coll. of North Wales, Bangor); Prydz, S. Appl. Opt.; 9: 503-5(Feb 1970).

The operation of a photon-counting, one-dimensional image detector which operates on the principle that secondary electron multiplication along a continuous dynode strip can be employed to locate the spatial origin of single electrons ejected from a photocathode is studied. The variance of the output pulse-height distribution is obtained and used to place an upper limit on the spatial resolution of the system. (W.H.K.)

19276 FATIGUE EFFECTS ON THE AREA SENSITIVITY, DYNODE GAIN, AND ANODE OUTPUT FOR SEVERAL END-ON PHOTOMULTIPLIERS. Youngbluth, O. Jr. (Langley Research Center, Hampton, Va.). Appl. Opt.; 9: 321-8(Feb 1970).

Instrumentation was developed to determine the time dependent effect of incident illumination on the area sensitivity and the gain stability of photomultipliers. Five end-on, S-11 photomultipliers were tested (6292, 2020, 6342A, 6655A, and 8053). The anode current variations were measured for a period of 3 h, the last three dynode gains were calculated, and the area sensitivity maps of these photomultipliers were recorded for several levels of illumination. It was found that: (1) with a constant light input to the multipliers tested, the output (anode current) varied up to 10% for the most stable tube (6342A) to over 400% for the most unstable tube (6292); (2) the relative sensitivity over each tube face (photocathode) area remained unchanged; (3) the photomultipliers can recover to more than one internal state (the condition

of the dynode surfaces); (4) the variation of photomultiplier gain with time depends on the dynode structure and coating; (5) the earlier stages contribute as much to gain instability as do the last three stages; (6) the focus electrode voltage producing the most uniform area sensitivity differs slightly (~5%) from the voltage for maximum anode current. (auth)

19277 FLASH X-RAY MACHINES. Paschal, Frank L. Jr. (General Dynamics/Fort Worth, Tex.). Amer. Ind. Hyg. Ass. J.; 31: 109-12(Jan-Feb 1970).

The flash x-ray machine produces a pulsed x-ray beam of short duration (0.1 microsecond) and very high intensity (10^7 R/sec). Pulses may be repeated at one minute intervals. Voltages as high as 750,000 may be applied to the tube. The machine provides a very penetrating source for high-speed radiography. Problems of adequate shielding and procedures to provide an acceptable installation and of measurement of dose delivered are discussed. (auth)

19278 CONSTRUCTION OF AN ENCLOSURE FOR THE STUDY OF THIN METALLIC FILMS UNDER STATIC HIGH VACUUM. APPLICATION TO THE STUDY OF THE OPTICAL PROPERTIES OF YTTRIUM. Petrakian, J. P.; Palmari, J. P. (Laboratoire de Physique Generale, Marseille). Thin Solid Films; 4: 423-7(Dec 1969). (In French).

An apparatus designed for the study, in static ultra-high vacuum, of the optical properties of very oxidizable materials, such as thin films of rare earths, is described. This apparatus allows working under very clean vacuum (about 10^{-9} torr) in a bell jar evacuated by an ion pump. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 19973.

19279 IONIZIRUYUSHCHIE IZLUCHENIYA I ELEKTRONIKA. (Ionizing Radiation and Electronics). Shirshev, Lev Georievich. Moscow; Izdatel'stvo Sovetskoe Radio (1969). 192p.

Information on the types and nature of ionizing radiations which affect radio electronic equipment and components is presented. Information on the units of measurement for the physical values of ionizing radiation is presented. These data are presented with the generally accepted units of measurement of the USSR with an introduction of the international system of units of measure. The possible operating conditions for radio equipment and their assembled components in a field of ionizing radiations are examined. Physical representations on the nature of the interaction of charged particles and quantum radiation with materials are presented. The types of radiation damage in materials and components of electronic equipment are examined. Some data on the radiation stability of materials used in radio technology, of radio components, and of individual electronic equipment are presented. (auth)

19280 FATIGUE OF ELECTRO-X RAY SELENIUM PLATES ON IRRADIATION WITH GAMMA RAYS. Rakauskas, Yu. K. (Research Inst. of Electrography, Vilnyus, USSR). Zh. Nauch. Prikl. Fotogr. Kinematogr.; 14: 435-7(Nov-Dec 1969). (In Russian).

Fatigue was defined as a decrease in photosensitivity after irradiation with gamma rays from thulium-170, cesium-137 and iridium-192. The amount of fatigue depended on the irradiation dose. The increase in fatigue with decreasing energy of gamma quanta can be explained by an increase in the amount of absorbed energy in the selenium layer. A saturation effect was noted at higher irradiation doses. The photosensitivity of the selenium plates is completely restored after storage for 18 hours in the dark at room temperature. Apparently thermal generation of current carriers from deep traps is sufficient to remove the volume charges. These results show that the decrease in photosensitivity does not hinder the use of selenium plates in applications involving gamma irradiation, since the greatest observed fatigue on irradiating with thulium-170 gamma rays is comparable with the fatigue observed on irradiating with x rays. The fatigue observed on irradiating with Cs-137 and Ir-192 gamma rays was significantly lower. (TTT)

19281 RADIATION EFFECTS IN SILICON DIODES. Panknin, D.; Balarin, M.; Wieting, J. (Institut fuer Metallphysik und Reinstmetalle, Dresden). Kernenergie; 12: 382-6(Dec 1969). (In German).

Changes in the volt-ampere characteristics of some commercial silicon diodes (ZA 250/14; ZA 250/9, OA 903) as the result of an irradiation with 10^{13} to 10^{18} fast neutrons/cm^2 at T = 30 to 40°C have been investigated within the temperature range from −190 to +80°C. Significant deterioration of the Zener diodes was found from about 10^{14} fast neutrons/cm^2; at 10^{17} fast neutrons/cm^2 the diode has already degenerated into purely ohmic resistor. The changes in temperature dependency have been evaluated. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

19282 IODINATION OF SERUM PROTEINS IN VIVO: RELATIONSHIP TO IRRADIATION AND HYPERTROPHY OF THE THYROID. Triantaphyllidis, E.; Thompson, B. D.; Barnaby, C. F.; Jasani, B. (University Coll., London). J. Endocrinol.; 44: 467-74(1969).

Conditions were sought for producing high levels of radioiodine-labeled serum protein in the rat. Levels were investigated in rats with either normal, nonhypertrophied thyroids containing large follicles full of colloid, or with hypertrophied thyroids containing little or no colloid. Levels of iodoprotein were compared after low thyroid irradiating doses of ^{125}I or high doses of ^{131}I, to evaluate the importance of radiation damage in their formation. The ^{125}I was used to produce low irradiation doses not exceeding 600 rad on the first day after the dose, and ^{131}I was used to produce higher doses of 50,000 to 70,000 rad during the same period. The high doses caused complete destruction of the thyroid as indicated by the high levels of circulating labeled thyroglobulin, the failure to demonstrate radioiodine concentration at a later date, and development of hypothyroidism. Histological examination of the thyroid area in a few animals failed to show any tissue recognizable as thyroid. Low levels of labeled serum protein were found in rats with normal thyroids after low or high thyroid-irradiating doses of radioiodine. The levels in rats with hypertrophied thyroids after low thyroid-irradiating doses of ^{125}I did not differ greatly from those in rats with normal thyroids. The mechanism of serum protein labeling is discussed and it is suggested that similar conditions may be important for the production of high levels of labeled serum protein in patients treated with radioactive iodine for functioning thyroid carcinoma. (BBB)

19283 MEASUREMENT OF PLASMA CORTISOL IN CHILDREN AND ADULTS: A COMPARISON OF THE DOUBLE ISOTOPE DERIVATIVE ASSAY, COMPETITIVE PROTEIN-BINDING ANALYSIS, AND THE MODIFIED COMPETITIVE PROTEIN-BINDING ANALYSIS. Iturzaeta, Nenita F.; Hillman, Donald A.; Colle, Eleanor (Montreal Children's Hospital, McGill Univ., Montreal). J. Clin. Endocrinol. Metab.; 30: 185-9(Feb 1970).

In normal adults and children, newborn infants, and patients with adrenogenital syndrome, plasma cortisol concentrations were measured by double isotope derivative assay (DIDA), competitive protein-binding analysis (CPBA), and modified competitive protein-binding analysis (Modified CPBA). A good correlation was observed between the values obtained in normal adults and children using the DIDA and CPBA; however, a large discrepancy was observed in the values obtained in newborns and patients with the adrenogenital syndrome, the CPBA giving much higher levels. This difference was attributed to the presence in these plasmas of other structurally related steroids that could compete with the binding of cortisol on transcortin. The specificity of the CPBA was improved by a modification involving paper chromatographic purification of cortisol prior to quantification by CPBA. The values thus obtained correspond to the cortisol concentration measured by DIDA and therefore provide a more accurate index of adrenocortical function. (auth)

19284 A METHOD OF SOLID PHASE RADIOIMMUNOASSAY UTILIZING POLYPROPYLENE DISCS. Crosignani, Pier Giorgio; Nakamura, Robert M.; Hovland, David N.; Mishell, Daniel R. Jr. (Harbor General Hospital, Torrance, Calif. Univ. of California, Los Angeles). J. Clin. Endocrinol. Metab.; 30: 153-60(Feb 1970).

A new solid phase method of radioimmunoassay was developed utilizing easily obtained, inexpensive discs of polypropylene. Study of the kinetics of binding of antibody to the discs revealed that binding capacity was related to pH as well as molarity of various buffers. In these solutions maximal binding is constantly achieved in 2 hr and persists in a stable state after lyophilization. This method was used to assay serum human chorionic gonadotropin (HCG), luteinizing hormone (LH), and human placental lactogen (HPL). For serum LH the linear range of this assay method is from 4.2 to 52 μg/100 ml (radioimmunoassay, LER 907 standard) using NIH anti-HCG. For HPL the linear range is from 0.1 to 3 ng/ml of the 98% pure Lederle preparation. In contrast to the 3 to 5 days required for the double antibody method, this degree of sensitivity is obtained after only 18-hr incubation. Assay of HCG and HPL from the same serum samples obtained from five women at intervals from delivery to 3 days post partum confirmed that these hormones have different disappearance rates, the half-life being 20 min for HPL and 5 hr for HCG. Assay of LH in serum from menstruating women also yielded physiologic results, thus providing additional evidence for the specificity of the method. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 18909, 19309, 19320, 19325, 19333, 19336, and 19352.

19285 (CONF-680657-2) INTERNAL CONTAMINATION WITH TRITIUM. Minder, Walter. Translated by S. M. Sanders (E. I. du Pont de Nemours and Co., Aiken, S. C.), from Strahlentherapie; 137: 700-4(1969). 6p. Dep. CFSTI.

From 6th Annual Meeting of the European Society for Radiation Biology, Interlaken, Switzerland.

Clinical and post-mortum analyses of urine and tissue samples were used to determine the tritium oxide content of the body fluids of a man exposed over a period of years, in a luminous paint factory, to tritium gas. Data on the tritium activity in different organs and the time course of tritium contamination are presented in graphic and tabular forms. On the basis of the activity in the organs and urine and the time course of contamination, the biological half-life of tritium in the individual was calculated. It was concluded that the continued inhalation of high concentrations of tritium gas in the breathing air on the part of this individual led to the irreversible injuries noted in the analyses. (E.R.B.)

19286 (MIT-952-6, pp 1-132) RADIUM AND MESOTHORIUM TOXICITY IN HUMAN BEINGS. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

The dose-vs.-response relation derived from an analysis of 604 cases that were studied in the Radioactivity Center is reviewed. Radium and mesothorium burdens in over 100 cases are presented in tabular form. Following a discussion of procedures and data required in a study of ^{226}Ra metabolism, an inventory of blood, urine, and feces specimens on hand at the Center for radium and calcium determinations is given. A preliminary study using x-ray fluorescence for calcium analysis is discussed. The RaF/Ra and RdTh/Ra ratios were determined in bone samples by thick-source α spectroscopy and tables containing these data are presented. Autoradiography at low resolution was used to determine distribution patterns of α emitters in thin bone sections. The results of these investigations are summarized and the number of partially and fully plugged Haversian canals (used as a response parameter) is tabulated. Blood and excreta were collected over a period of several months from a former Swiss dial painter visiting the Center, also whole-body measurements were made of ^{90}Sr and ^{226}Ra burdens. Several whole-body counting facilities were visited by the dial painter, where data were obtained for interlaboratory comparison. A program to follow the medical histories of patients studied at the Center, and the evolution of the Central Catalog of cases are also discussed. (E.R.B.)

19287 (MIT-952-6, pp 155-63) GENERAL RADIOBIOLOGY. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

The periodic measurement of the ^{137}Cs content of normal human subjects was continued on four of the original six subjects previously reported on, and on one new subject who had been living in Sweden. Plotting of the data revealed rather stable smooth curves for the four original subjects with the exception of a slight rise in September and October. The new subject had considerably higher ^{137}Cs levels than the others when counting first started. The relation between potassium and protein requirements during exercise in young adults was studied by measuring the γ ray of a ^{40}K tracer using a whole-body counter. Graphs of the preliminary data are presented, but the final correlations, blood and urine studies, and conclusions drawn from the study to date will be published in the near future. Whole-body and fractional potassium determinations were made periodically in pregnant women, and once after parturition. Potassium-40 γ rays were measured using a whole-body counter with the subject in the standard chair position. Results, which are incomplete to date, indicate that whole-body potassium increased late in pregnancy while fractional potassium (whole-body potassium as a fraction of body weight) showed no clear indication of change. Post-partum whole-body potassium values showed a significant decrease while fractional potassium values remained high. (E.R.B.)

19288 (MIT-952-6, pp 185-211) URANIUM MINE DOSIMETRY AND RADIATION CONTROL. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics).

Five independent approaches to the study of the problem of permissible radon daughter product concentrations in uranium miners are examined. Although no one approach can yield a fully unequivocal specification of the biological response of human beings to all different levels of concentration of airborne radon daughter products, there is an internal mutual consistency that strongly supports the interpretation that an average exposure to 12 working level months (WLM) per year, as recommended by the FRC and approved by President Johnson in 1967, is a conservative and safe standard. These five radiobiological approaches include: lung model computations, the carcinogenic response of man to internal burdens of radium and mesothorium, the induction of paranasal sinus and mastoid carcinomas by skeletal deposits of radium, the absence of lung carcinomas in patients injected with Thorotrast, and the epidemiology of lung cancer among underground miners of uranium, other metals, and coal. Each of these five approaches was based on the long-term continuous irradiation of human tissue by α emitters. Each approach is discussed in detail. An extensive analysis is presented of certain aspects of the testimony of one of the witnesses at the hearings on Safety and Health Standards conducted by the Bureau of Labor Standards in 1968. A prototype of a portable instrument for determining (within 2 min.) the working levels within a mine was tested. The operation of the unit is based on the analysis of air filter samples of RaA and RaC -RaC' concentrations, which are measured discretely in two α-energy channels, and measurement of RaB plus RaC concentrations in a single β channel. Internal calculation of the concentrations of the four short-lived radon daughter products is followed by computation of the working level burden in the filtered air. All calculations are done in analog fashion and analog-to-digital conversion provides digital readout of the data directly as working levels. The status of the development of a personal monitor for measuring cumulative exposure to working levels is also reported. (E.R.B.)

19289 REDUCTION IN THE PLANT UPTAKE OF ^{90}Sr BY SOIL MANAGEMENT TREATMENTS. Frere, M. H.; Menzel, R. G.; Roberts, H. Jr.; Myhre, D. L.; Amemiya, M.; Beale, O. W.; Timmons, D. R.; Wood, E. H. (Agricultural Research Service, Washington, D. C.). U. S., Dep. Agr., Tech. Bull.; No. 1378, 38p (Nov 1967).

The effectiveness of deep plowing in conjunction with irrigation and additions of calcium and potassium to the surface soil for reducing uptake of ^{90}Sr were evaluated. Calcium and potassium were selected for this study because there is ample evidence in the literature that they decrease Sr uptake and because they are commonly used by the farmer. The uptake of ^{90}Sr was determined from field experiments utilizing ^{90}Sr already deposited in worldwide fallout. Because of continuing fallout, it was necessary to estimate the amount of ^{90}Sr deposited directly on the crops. (E.R.B.)

19290 THYROIDAL HANDLING OF RADIOIODINE DURING FASTING. Chaudhuri, B. N.; Yadav, H. S. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). Indian J. Med. Res.; 57: 1053-61(Jun 1969).

The effect of fasting on the metabolism of radioiodine was studied in rats by autoradiography and measurement of the thyroid/serum (T/S) radioiodide ratio. The rats received an intraperitoneal dose of 1.0 μCi ^{131}I for the determination of T/S ratio, whereas 0.5 μCi was administered prior to autoradiography. The earliest changes in thyroid function during complete deprivation of food could be characterized by this technique. Both 24- and 48-hr deprival of food caused progressive loss of body weight, but thyroid-to-body weight ratio remained unchanged. Compared to nonfasting controls, the 24-hr concentration of ^{131}I per unit weight of thyroid was increased by 40% or more in rats fasted for 24 hr. By 24 to 48 hr after administration of ^{131}I, the mean thyroid radioactivity was decreased by 20% in control rats, while in the experimental group continued fasting caused a further increase in thyroid radioactivity during the same period. In control rats, between 24 and 48 hr after receiving ^{131}I serum radioactivity was decreased by 50% with no further demonstrable change in serum concentration of ^{131}I to 72 hr. The 24-hr serum concentration of ^{131}I was reduced by 24% in rats fasted for 24 hr, and continued fasting for 72 hr did not further change the mean concentration of serum ^{131}I. The T/S ratio and 1-hr concentration of ^{131}I in the blocked thyroid gland were similar in control and rats fasted for 24 or 48 hr. The decreased discharge of thyroid hormones with unchanged intrathyroid availability of trapped iodide was considered responsible for the net increase in thyroid radioactivity during fasting. (BBB)

19291 MELATONIN AND ITS PRECURSORS' EFFECTS ON ^{131}I UPTAKE BY THE THYROID GLAND UNDER DIFFERENT PHOTIC CONDITIONS. DeProspo, N. D.; Safinski, R. J.; DeMartino, L. J.; McGuinness, E. T. (Seton Hall Univ., South Orange, N. J.). Life Sci.; 8: 837-42(Aug 1969).

The influence of the pineal hormone and its precursors on the uptake of ^{131}I by the thyroid gland when the photic environment was altered was studied. Young female rats were kept for 10 days under 1 of 3 photic conditions, including normal laboratory lighting, continuous light (L), or constant darkness (D). The regimen for each photic variation differed in 5 ways. These were daily intraperitoneal injections of melatonin, N-acetylserotonin, serotonin hydrogen oxalate, or 5-hydroxytryptophan. The doses were 1 μg/g body wt. Each rat was injected with 0.5 μCi of ^{131}I/100 g body wt and killed 24 hr later. Continuous darkness decreased, and continuous light increased uptake of the ^{131}I. Melatonin and its precursors and particularly N-acetylserotonin depressed thyroid activity when ^{131}I was used as a criterion. It was not evident how melatonin and N-acetylserotonin influenced thyroid uptake of ^{131}I. Several interpretations are discussed. These included the possible role of the adenohypophysis, the hypothalamus, corticosterone production, and the possible influence of the pineal hormone and its precursors on general body activity. It was concluded that melatonin and its precursors directly or indirectly affect the activity of the thyroid gland under differing photic conditions. (BBB)

19292 SYSTEMIC EFFECTS OF RES-BLOCKING AGENTS IN THE DOG. Wiedmeier, V. Thomas; Johnson, Shirley A.; Siegesmund, A.; Smith, James J. (Marquette School of Medicine, Milwaukee). RES, J. Reticuloendothel. Soc.; 6: 202-20(Apr 1969).

Toxic actions of colloidal ThO_2 and other agents used to assess reticuloendothelial system (RES) blockade were analyzed. Blocking doses of 2000 mg/Kg of ThO_2 and various amounts of SiO_2, colloidal C, or polystyrene latex were administered intravenously to dogs. The ThO_2 consisted of 24 to 26% colloidal ThO_2 (Thorotrast), with a mean particle size of ~75 Å. The ThO_2 produced no subsequent mortality. Electron microscopy studies showed that ThO_2 particles were present in large numbers in Kupffer cell cytoplasm and liver sinusoids, and in polymorphonuclear leukocytes, splenic cells, and lining cells of the lung. None of the cells of the animals injected with ThO_2 showed any apparent damage, even in areas of heavy colloid concentration. The organelles containing the colloid maintained their integrity and the particles remained confined within these structures. Pathological and histological studies made at autopsy showed that gross changes were minimal. Plasma fibrinogen values declined markedly and abruptly after ThO_2, and the partial thromboplastin time was prolonged moderately in the ThO_2 animals. All colloids caused prompt blood coagulation defects, most marked after ThO_2, C, and Syton. It was not explained why these different inert colloids had widely divergent cytotoxic effects, or how such toxicity was related to the RES-blocking action. It seemed evident that the possibility of such associated toxic effects should be considered when assessing the effectiveness and utility of RES test agents. (BBB)

19293 THE DISTRIBUTION OF ^{99m}Tc AND ^{131}I IN THE GASTRIC MUCOSA. A CONTRIBUTION TO THE METHODOLOGY OF MICROHISTOAUTORADIOGRAPHY OF WATER SOLUBLE ISOTOPES. Meier-Ruge, W.; Fridrich, R. (Medizinisch-Biologische Forschung, Basel). Histochemie; 19: 147-54(28 Jul 1969). (In German).

A method for microhistoautoradiographic examination of water soluble radioactive isotopes and its use in studying the distribution of ^{131}I and ^{99m}Tc in the gastric mucosa was described. The ^{99m}Tc was selectively secreted by the parietal cells of the gastric mucosa. In contrast, ^{131}I was secreted by the chief and mucosal cells. The selective accumulation of ^{99m}Tc in the parietal cells suggested ^{99m}Tc was secreted via a metabolic pathway. Most of the activity of ^{99m}Tc was observed in the gastric fundus. The distribution of ^{99m}Tc and ^{131}I within the submucous lymphoid and capillary vessels of the antrum and fundus was equal. The microhistoautoradiographic results in the different parts of the stomach were confirmed by quantitative scintillation counting. (BBB)

19294 AUTORADIOGRAPHIC METHOD FOR QUANTITATION OF DEPOSITION AND DISTRIBUTION OF RADIOCALCIUM IN BONE. Riggs, B. Lawrence Jr.; Bassingthwaighte, James B.; Jowsey, Jenifer; Pequegnat, E. Peter (Mayo Clinic, Rochester, Minn. Mayo Foundation, Rochester, Minn.). J. Lab. Clin. Med.; 75: 520-8(Mar 1970).

A method is described for quantitating autoradiographs of bone-seeking isotopes in microscopic sections of bone. Autoradiographs of bone sections containing ^{45}Ca and internal calibration standards are automatically scanned with a microdensitometer. The digitized optical density output is stored on magnetic tape and is converted by computer to equivalent activity of ^{45}Ca per gram of bone. The computer determines the total ^{45}Ca uptake in the bone section and, on the basis of optical density and anatomic position, quantitatively divides the uptake into four components, each representing a separate physiologic process (bone formation, secondary mineraliza-

tion, diffuse long-term exchange, and surface short-term exchange). The method is also applicable for quantitative analysis of microradiographs of bone sections for mineral content and density. (auth)

Radiation Effects

Refer also to abstracts 19003, 19330, and 19345.

19295 (AEC-tr-7109) RADIOBIOLOGY. Volume IX, Number 4. Translation of Radiobiologiya; 9: 483-652(1969). 261p. Dep. CFSTI.

Abstracts of papers within the scope of NSA were prepared from the original language journal. To refer to any of these abstracts, consult the NSA Author Indexes. (E.R.B.)

19296 (AEC-tr-7136) RADIOBIOLOGY. Translation of Radiobiologiya; 9: No. 5, 659-792(1969). 209p. Dep. CFSTI.

Abstracts of papers within the scope of NSA were prepared from the original language journal. To refer to any of these abstracts, consult the NSA Author Indexes. (E.R.B.)

19297 (CONF-680843-(Absts.)) FIFTH INTERNATIONAL CONGRESS ON PHOTOBIOLOGY, HANOVER, NEW HAMPSHIRE, 1968. (International Congress on Photobiology). 174p.

Abstracts of the 355 papers are presented in the order of presentation at the conference. The major topics include: photochemistry; photodynamic action; photosynthesis; bioluminescence; macromolecules; dermatology carcinogenesis; photomorphogenesis; phototropism phototaxis; vision; rhythms; instrumentation action spectra; repair; and ionizing and uv radiation. (C.O.)

19298 (COO-1704-15) CORRELATION BETWEEN RADIATION AND CHEMICAL INDUCED MOLECULAR DAMAGES AND THEIR BIOLOGICAL EXPRESSION IN MAMMALIAN CELLS. Annual Technical Progress Report. Trosko, James E. (Michigan State Univ., East Lansing). 14 Jan 1970. Contract AT-(11-1)-1704. 21p. Dep. CFSTI.

Cells of xeroderma pigmentosum patients were examined with regard to their ability to excise uv-induced pyrimidine dimers. Analysis of dimers in uv-irradiated cells indicated that the cells are deficient for dark repair enzyme activity. It was found that at relatively low doses the repair of pyrimidine dimers by excision reaches saturation level. Studies were conducted on synergistic effects of uv light and caffeine in human cells. Studies on effects of natural sunlight on the production of dimers in human cells revealed that a 5 hour exposure caused severe sunburn and also induced a significant amount of pyrimidine dimers. Investigations on photoreactivation indicated that direct photoreactivation, as manifested by monomerization of uv-induced pyrimidine dimers, does not exist in AV_3 or HeLa cells, and that DNA synthesis is not photoreactivated. Studies were conducted on effects of platinum, irradiated sugars, and trisoralen on human cells. When Chinese hamster cells were uv-irradiated, extracellular DNA degradation led to an accumulation of thymidine and thymine in the medium; intracellular degradation also occurred, and the acid-soluble fraction of the cells contained polynucleotides, phosphorylated derivatives of thymidine and thymine. (H.L.W.)

19299 ACID-BASE BALANCE IN THE DOG FOLLOWING X-IRRADIATION. Welbourne, Tomas C.; Spurr, G. B. (Univ. of Tennessee, Memphis). Radiat. Res.; 41: 352-61(Feb 1970).

The acid-base balance of 22 adult, female, uninephrectomized dogs was studied prior to and for 11 days following exposure to 400 R whole-body x-irradiation. Acid-base balance was evaluated by simultaneously measuring renal net acid excretion, apparent metabolic acid production, and body fluid acid-base changes. The first 6 days following irradiation, net acid excretion was significantly elevated and apparent metabolic acid production appeared to increase. Whole-body intracellular pH was significantly elevated on the 5th day postirradiation, suggesting a movement of acid from the intracellular space to the urine during this time. During the last 5 days a compensated metabolic acidosis was present in the extracellular fluid, while the whole-body intracellular pH was decreased on the 11th day postirradiation. Acid excretion tended to decrease while apparent metabolic acid production returned to control levels. The development of acidosis at this time, without an increase in acid excretion, suggests an alteration in renal acid-base regulation. (auth)

19300 IMMUNIZATION OF C58 MICE TO LINE I_b LEUKEMIA. Lin, Juey Shin Lai; Huber, Nancy; Murphy, William H. (Univ. of Michigan, Ann Arbor). Cancer Res.; 29: 2157-62(Dec 1969).

A study was done to define the conditions that had to be met to immunize C58 mice to line I_b transplantable leukemia (I_b cells). The relative immunogenicity of I_b cell preparations inactivated by a variety of methods was compared. Cell preparations were inactivated by exposure to uv light for up to 60 minutes. A cell concentration of 10^6 to 10^7 per ml exposed to uv light for 15 to 30 minutes was the most immunogenic. A dose of 10^5 cells per ml was only weakly immunogenic. A dose of 10^8 uv-irradiated cells killed all of the recipient mice. However, when 10^8 cells were exposed to 15,000 R of x radiation they were strongly immunogenic; a 10^5 cell dose exposed to 5,000 to 15,000 R was not immunogenic. A preparation of 10^7 cells per ml exposed to 5,000 to 15,000 R was the most immunogenic. The optimum method for inactivating cells with formalin was by exposure to a 1:500 dilution for 18 hours at 4°C. A dose of 10^7 cells per ml was the most immunogenic. Frozen-thawed, sonicated-lyophilized, and sonicated-filtered preparations were immunogenic, providing that the initial cell concentration was about 10^8 per ml and that the proper dose regimen was used for immunization. Freund's complete adjuvant impaired the immune response of C58 mice to uv-, x-irradiated, or formalin-treated cell cell preparations. Quantitative studies of cell-associated immunity to line I_b leukemia were carried out. Immune lymphoid cells were obtained from the spleen, lymph nodes, and peritoneal cavity of immune C58 mice. A ratio of 10 immune cells to 1 I_b cell was necessary to afford complete protection. When mice were immunized by a single injection of formalinized or uv-inactivated cells, immunity persisted at a high level for approximately one year. (auth)

19301 INFLUENCE OF RELATIVE HUMIDITY ON THE PHOTOCHEMISTRY OF DNA FILMS. Rahn, R. O.; Hosszu, J. L. (Oak Ridge National Lab., Tenn.). Biochim. Biophys. Acta; 190: 126-31(17 Sep 1969).

Films of Escherichia coli DNA labeled with ^3H-thymine were prepared on quartz plates by spreading out 0.01 to 0.025 ml of the DNA solution (0.2 mg/ml). The films were then equilibrated at various relative humidities and irradiated with uv light at 25° so that changes in their photochemistry could be correlated with known conformational changes. The samples were irradiated at 254 nm with a low-pressure mercury lamp and at 280 nm with a high-pressure mercury lamp. Above 65% relative humidity the photochemical behavior of the films was the same as that in solution, with pyrimidine dimers, but few if any photoproducts such as those seen in irradiated bacterial spores, being formed. Below 65% relative humidity there was a two-fold reduction in the yield of thymine dimers and a concomitant increase in the yield of spore photoproducts. These photochemical changes are consistent with the known conformational change in DNA films to a disorganized form as the relative humidity is reduced. (BBB)

19302 RADICAL FORMATION IN CYSTEAMINE-HCL GAMMA-IRRADIATED IN THE DRY STATE AND IN FROZEN AQUEOUS SOLUTION. Copeland, E. S.; Swartz, H. M. (Walter Reed Army Medical Centre, Washington, D. C.). Int. J. Radiat. Biol.; 16: 293-6(1969).

Gamma-irradiations were performed with a ^{60}Co source at a dose rate of 13k rads per minute while the samples were kept at 77°K. The total dose was 0.5 M rads. After E.S.R. observation at 77°K immediately after irradiation, samples were heat-tested for 3 min at predetermined temperatures and then returned to 77°K for further observation. In the temperature range 170°K to 190°K, where cysteamine radicals transform in frozen aqueous solution, there was no corresponding change in radicals formed in solid cysteamine. The organosulphur radical in the solid state appeared to transform fully only after annealing for 3 min at 298°K. The evolution of E.S.R. spectral shape on annealing in either system was thought to result from a transformation of the cysteamine radical ion formed at 77°K into the stable neutral organosulphur radical. The spectra were observed with the pH at various values before freezing. At pH 2 the cysteamine solute had an electronic structure analogous to that in polycrystalline cysteamine hydrochloride, whereas at pH 9 82% of the solution had an electronic structure like that in cysteamine freebase. The type or radical formed in irradiated cysteamine thus appeared to depend more on the degree of dissociation of the thiol group than on the radiation quantum size. (U.K.)

19303 HISTONE SYNTHESIS IN POLYOMA- AND SV40-INFECTED CELLS. Winocour, Ernest; Robbins, Elliott (Albert Einstein Coll. of Medicine, Bronx, N. Y.). Virology; 40: 307-15(Feb 1970).

Using acrylamide gel electrophoresis of acid-soluble nuclear proteins (labeled with tryptophan-^3H and lysine-^{14}C) to monitor histone synthesis, it was found that the virus-promoted synthesis of cellular DNA is accompanied by a stimulation of histone synthesis in polyoma-infected primary mouse kidney cells, polyoma-infected hamster BHK21 cells, SV40-infected mouse 3T3 cells, and SV40-infected, x-irradiated (5000 rads) mouse 3T3 cells. An induction of mitotic activity was also found in the x-irradiated, SV40-infected 3T3 cells. (auth)

19304 EFFECT OF X-IRRADIATION ON DNA SYNTHESIS AND CELL PROLIFERATION IN THE INTESTINAL EPITHELIAL CELLS OF GOLDFISH AT DIFFERENT TEMPERATURES WITH SPECIAL REFERENCE TO RECOVERY PROCESS. Hyodo-Taguchi, Yasuko (National Inst. of Radiological Sciences, Chiba, Japan). Radiat Res.; 41: 508-78(Mar 1970).

The cell population kinetics in intestinal epithelium of intact goldfish and radioinduced changes in DNA synthesis, mitotic activity, and generation cycle in the intestinal epithelium were studied at 25 and 15°C. If fish were injected with ^{3}H-thymidine just after irradiation with 1, 2, or 8 kR of x rays and sacrificed at various times after injection, the number of labeled cells did not differ appreciably from the nonirradiated control within 3 and 6 hr after the injection at 25 and 15°C, respectively. After this period, labeled cells degenerated and the number of labeled cells approached zero within 24 (25°C) or 48 (15°C) hr in the 8-kR group. On the other hand, in the 1- or 2-kR groups the number of labeled cells recovered after temporary reduction; cell recovery at 15°C took longer than at 25°C. In fish injected with ^{3}H-thymidine at different times after irradiation, the time course of depression and recovery in DNA synthesis and subsequent cell division was observed at different temperatures. After all three doses, DNA synthesis occurred in many cells within 12 hr at 25°C and 24 hr at 15°C after irradiation, and the number of labeled cells reached a minimum after 24 hr at 25°C and 48 hr at 15°C, respectively. After these periods, activity of DNA synthesis in the 1- and 2-kR groups recovered to a normal level between 48 and 72 hr at 25°C and between 72 and 120 hr at 15°C. Recovery in mitotic activity also occurred between 48 and 72 hr at 25°C and between 72 and 96 hr at 15°C after the initial fall. Changes in G_2 and S stages in generation cycles of epithelial cells after irradiation were shown. (auth)

Immunology

19305 THE METABOLISM OF DIFFERENT IMMUNOGLOBULIN CLASSES IN IRRADIATED MICE. I. CATABOLISM. Bazin, H.; Malet, France (Institut du Radium, Paris). Immunology; 17: 345-65(Sep 1969).

The catabolism of the different classes of immunoglobulins (Ig) in normal and irradiated mice was studied. Mice strains XVII, C3H, C57/BL, and BALB/c were employed. Some of the XVII mice were subjected to whole-body x irradiation with a dose of 950 R, which normally produces a 100% mortality rate nine to 12 days after irradiation. This dose of x rays brought about no significant alterations in the catabolic rates of IgM and IgA, which had a half-life time of about 12 hr. However, the IgG (IgG_1, IgG_{2a}, and IgG_{2b}) displayed a distinctly accelerated catabolism in the irradiated mice, the half-life of these Ig's being reduced by ~½. To explain this phenomenon, the marked radiosensitivity of the intestinal epithelium and the mode of catabolism of IgM and IgA (which appears to be different from that of IgG) are considered. Enhanced IgG catabolism in irradiated mice was probably caused by intestinal lesions. In exudative gastroenteropathies the serum IgM level remains normal, whereas the IgA and IgG levels fall owing to intestinal losses. (BBB)

19306 THYMUS IRRADIATION AND RENAL TRANSPLANTS. Calzavara, F.; Scutari, A.; Rossetto, S. (Univ., Padua). Urologia (Italy); 36: 3-11(20 Feb 1969). (In Italian).

The acceptance of subcutaneous transplants of kidney as affected by thymus irradiation was studied. Transplantation was carried out in rats after irradiation of the thymus with 2000 R. The homologous grafts were carried out in Wistar rats. In the nonirradiated rats the renal grafts were undergoing resorption when examined 20 days after transplantation. In the rats given thymus irradiation, at 20 days the renal grafts showed normal cytology. The results confirm the intervention of the thymus in the immunologic process. Irradiation of the thymus caused an appreciable drop in serum antibody levels, which may help to explain the increased tolerance to grafts in the irradiated animals. (BBB)

19307 CELLULAR RESPONSE OF MICE TO INFECTION WITH PASTEURELLA TULARENSIS (LIVE VACCINE STRAIN) FOLLOWING CONTINUOUS EXPOSURE TO LOW-DOSE γ RADIATION. Silverman, Myron S.; Greenman, V.; McKee, A. E.; Hadley, K.; Hodge, F. A.; Burriss, C. (Naval Radiological Defense Lab., San Francisco). J. Infect. Dis.; 120: 366-71(Sep 1969).

PASTEURELLA tularensis live vaccine is an effective immunizing agent in animals, including man, when administered by intradermal or subcutaneous injections, orally, or as an aerosol. However, continuous exposure to ^{60}Co γ radiation delivered at 1.0 to 1.5 R/hr increased the susceptibility of mice to infection with this strain provided that the total accumulated dose was sufficiently high, 2000 R or greater. Since no apparent reasons for the increased susceptibility of irradiated mice were obtained by bacteriological studies, a comparison of the cellular changes in the lungs and the histology of the lungs, liver, spleen, and lymph nodes was undertaken. Lung washings suggested that a decrease in the number of phagocytic cells, both polymorphonuclear cells and macrophages, mobilized in the irradiated animals after infection might be a reason for the greater susceptibility. The phagocytes that were present, however, appeared to be more active, as indicated by the higher percentage of cells phagocytizing the organism and the greater number of the bacteria ingested per cell. An alternative reason for the apparent increased activity could be that a decreased bactericidal capability of the cells permitted an increased intracellular bacterial proliferation. Examination of sections of lung, spleen, liver, and lymph nodes revealed a more rapid appearance of lesions in the irradiated group compared with the nonirradiated mice. There were no obvious differences, however, in the nature of the lesions. In contrast to studies on the histology of tularemia in monkeys, in which histiocytes were the predominant phagocytic cell, there appeared to be more polymorphonuclear leukocytes in infected mice. Immune irradiated mice responded with an increased histiocytic and plasma cell mobilization. Although some pathologic lesions were seen in these mice, they occurred to a lesser degree than in either irradiated or nonirradiated nonimmune mice. (BBB)

19308 FORMATION OF SPLEEN COLONIES IN MICE INJECTED WITH PRE-IRRADIATED MARROW. Haot, J. (Univ., Liege). Compt. Rend. Soc. Biol., 162: 2041-3(1968). (In French).

Four groups of 50 to 70 female mice each received a total-body irradiation at a lethal dose of 900 rads x rays. Twenty hours later they were injected with a suspension of 25,000 bone marrow cells from normal mice of the same strain, age, and sex, or from mice of the same strain which had received a sublethal irradiation of 400 rad nine, 12, or 14 days before. After eight days the surviving mice were sacrificed, their spleens were removed and fixed in Bouin's liquid for examination after 24 hours. Only the large spleen colonies were counted, including secondary colonies. The mean cell type composition of the bone marrow of the donor mice nine, 12, and 14 days after irradiation was determined. Results showed that the number of cells capable of producing spleen colonies increased slightly from the 9th to the 12th day after irradiation and fell off at the 14th day. The increase was not connected with the presence of abnormal lymphocytes appearing after sublethal irradiation since no extraordinary increase of spleenic cells could be observed in mice injected with the bone marrow of sublethally irradiated mice 12 days after irradiation. This fact makes it unlikely that a relation exists between the abnormal lymphocytes and the original hematopoietic bone marrow cells. (F.J.W.)

Ecology

Refer also to abstract 19289.

19309 ^{210}Pb AND ^{210}Po IN TISSUES OF SOME ALASKAN RESIDENTS AS RELATED TO CONSUMPTION OF CARIBOU OR REINDEER MEAT. Blanchard, R. L.; Moore, J. B. (Public Health Service, Cincinnati). Health Phys.; 18: 127-34(Feb 1970).

Concentrations of ^{210}Pb and ^{210}Po in tissues of Alaskans who eat caribou meat are compared with the concentrations in tissues of individuals whose diets do not include this meat. The levels of ^{210}Po were significantly higher in those individuals who had eaten caribou meat a short time before death; however, only small differences were observed in the ^{210}Pb levels between the two groups. The concentrations of ^{210}Pb and ^{210}Po in lichen and in caribou bone samples which were collected prior to the advent of nuclear testing in the arctic were not found to differ significantly from the concentrations in similar samples recently collected. These results indicate that nuclear fallout has not significantly increased the ^{210}Pb levels in the arctic environment. (auth) (UK)

Genetics and Cytogenetics

Refer also to abstracts 19329, 19350, 19353, and 19377.

19310 INFLUENCE OF TEMPERATURE AT IRRADIATION IN VITRO ON THE YIELD OF CHROMOSOMAL ABERRATIONS IN PERIPHERAL BLOOD LYMPHOCYTES. Bajerska, Alina; Liniecki, Julian (Instytut Medycyny Pracy, Lodz, Poland). Int. J. Radiat. Biol.; 16: 483-93(1969).

The effect of temperature during in vitro irradiation of whole blood microcultures on the yield of chromosomal aberrations was studied. It was found that lowering the temperature from 37 to 20°C led to pronounced reduction in the yield of dicentrics and acentric fragments; the magnitude of similar effects on the yield

of rings and intercalary deletions could not be assessed firmly. Decreased temperature abolished the previously-reported dependence of the dicentric response curve on the dose-rate at which x-rays were delivered. It is postulated that lack of temperature control during irradiations is likely to be responsible for the main part of discrepancy between in vitro dose-effect relations for dicentrics as reported by various authors. (auth) (UK)

19311 DIFFERENT TYPES OF STERILITY INDUCED IN BARLEY BY IONIZING RADIATIONS AND CHEMICAL MUTAGENS. Ekberg, Inger (Royal Coll. of Forestry, Stockholm). Hereditas; 63: 257-78(1969).

An analysis was made of the genetic background of the induced partial sterility (the so-called translocation sterility type, or TS type) in X_1 and later generations following treatments of barley seeds with various mutagenic agents. Furthermore, a comparison was made of the TS type obtained following ionizing radiations with TS type induced by chemical mutagens of the alkylating agent variety. Barley plants showing this type of sterility were selected for the analysis of the mechanisms behind the partial sterility. From the selected plants sterile lines were established, and in X_2 and later generations data were collected concerning chromosome configurations at meiosis, seed-set and pollen fertility, segregation ratios and hereditary traits. The ionizing radiations used included neutrons and x rays, while chemical compounds with alkylating effects included alkanesulfonic esters, epoxides and ethyleneimines, and diethyl sulfate. Effects of oxygen and combined treatments with x rays and 8-ethoxycaffeine were also examined. The characteristics of the following five different types of sterility occurring in X_1 and later generations were reported: (1) translocations, (2) inversions, (3) lethals causing abortion in 25% of the seeds in heterozygous plants, (4) lethals causing abortion in 50% of the seeds or gametes in heterozygous plants, and (5) viable recessive mutations causing a more or less pronounced sterility in homozygous plants. Sterility types 1 to 4 were observed in the X_1 generation, whereas sterility type 5 did not appear until the X_2 generation. The ionizing radiations (neutrons and x rays) caused predominantly chromosome aberrations of sterility type 1 and 2 (82%). The chemicals, mostly of the alkylating type, mainly induced seed lethality (sterility type 3 and 4). The lines showing chromosome aberrations only constituted 27% of all analyzed lines following chemical treatments. The genetical background of lethality was discussed. (BBB)

19312 PITFALLS IN THE USE OF CHROMOSOME ABERRATION ANALYSIS FOR BIOLOGICAL RADIATION DOSIMETRY. Sharpe, H. B. A. (Royal Marsden Hospital, Sutton, Eng.). Brit. J. Radiol.; 42: 943-4(Dec 1969).

The peripheral blood of subjects that have received partial body irradiation or extracorporeal irradiation of the blood or lymph contains irradiated and non irradiated lymphocytes. Estimates of the dose received, based on the aberration yield are prone to error because cell death may occur unequally in irradiated and non irradiated cells and radiation may affect the time of mitosis. Attempts were made to determine the proportions of irradiated and non irradiated cells lost during culture. Equal numbers of irradiated and non irradiated cells were mixed and the resulting chromosome aberration yield of mixed culture was compared with the yield for irradiated and control cultures. In the first experiment cells were incubated for 48 hours before fixing. 100 cells for each control culture were examined and one dicentric recorded. The number of dicentric aberrations per mitotic cell in the mixed cultures was less than half that found in irradiated cultures. The measured yields compared with the expected were 74%, 62%, and 53% at 300, 500 and 700 rads of ^{60}Co γ rays. The experiment was repeated using culture time of 44, 47, 50, 53 hours. The changes in dicentric aberration yield with time varied significantly in cultures given 300 rads ($P < 0.001$), 500 rads ($0.01 > P > 0.001$) 700 rads ($0.05 > P > 0.02$). The number of aberrations in cultures given 500 rads and mixed with normal cells did not vary significantly. There was also an apparent peak in aberration yield that was delayed in increasing the radiation dose. A number of tetraploid cells were found in the cultures given 500 or 700 rads and fixed at 55 hours. (UK)

Health Physics and Safety

Refer also to abstract 19063.

Radioactive Contamination and Decontamination

Refer also to abstracts 19124, 19125, 19224, 19309, and 19379.

19313 METHOD AND MEANS FOR REMOVAL OF RADIOACTIVE CONTAMINANTS. Moroni, Rolf; Rinck, Friedrich Karl; Kisteneich, Peter (to Collo-Rheincollodium, Cologne, GmbH). U. S. Patent 3,487,916. 6 Jan 1970. Filed 31 May 1966.

To remove radioactive contaminants from the skin, polyurethane or phenol resin foam is used either in the form of granulate or sponge. In the foam material, 1 to 25% of a substance is incorporated that binds the radioactive contaminants by absorption and/or ion exchange. When skin is rubbed, tiny cells of the sponge remove and hold the superficial layers of the skin with its contamination. As parts of the foam material are used up, new cells with sharp edges become available and the cleaning and decontamination procedures continue. (H.B.G.)

19314 QUANTITIVE ASSESSMENT OF SOME METHODS FOR TESTING CLINICAL RADIUM CONTAINERS. Siuda, J.; Szymczyk, W.; Drejak, Z. (Inst. of Oncology, Krakow). Post. Fiz. Med.; No. 1, 13-16(1968). (In Polish).

A quantitative analysis of the efficiency of several methods of testing radium capsules for radon leakage was performed. According to the demands of radiation protection a threshold leakage (criterion of tightness) was established. (auth) (NSA of Poland)

19315 EXPERIMENTAL TEST OF THE DECONTAMINATION OF HEN'S EGGS EXTERNALLY CONTAMINATED WITH RADIOSTRONTIUM. Grunewald, H. Arch. Exp. Veterinaermed., 22: 689-95(1968). (In German).

From experiments on a total of 680 hen's eggs it was possible to show that, after external contamination of the eggs with ^{90}Sr, successful chemical decontamination is possible by putting the eggs for twenty hours in a 10% aqueous solution of FIT liquid or in a 1 to 5% solution of sodium citrate and subsequently rinsing the eggs under running water; or by putting the eggs for one hour in a 2 to 5% aqueous citric-acid solution or 5% acetic acid solution and subsequently rinsing them under running water. (auth)

19316 EFFECT OF ANIONIC ION EXCHANGE RESIN TREATMENT OF MILK FOR REMOVAL OF RADIOIODINE ON ITS THIAMINE CONTENT. Barth, Julius (Dept. of Health, Education, and Welfare, Rockville, Md.); Avants, Jimmy K.; Bruckner, Benjamin H.; Edmondson, Locke F. J. Agr. Food Chem.; 18: 524-5 (Mar-Apr 1970).

A laboratory scale experiment was carried out to determine the influence of an anion exchange procedure for removal of ^{131}I from milk on milk thiamine content. There were no changes observed in the free thiamine, bound thiamine, or total thiamine content of milk treated for ^{131}I removal by anion exchange resin. (auth)

Dosimetry and Monitoring

Refer also to abstracts 19096, 19203, 19218, 19223, 19242, 19247, and 19288.

19317 CALCULATION OF ABSORBED DOSE FROM EXPOSURE MEASUREMENTS: PRACTICAL PROBLEMS IN DOSIMETRY. Cunningham, J. R.; Johns, H. E. (Univ. of Toronto). Phys. Med. Biol.; 15: 71-7(Jan 1970).

At least two procedures for determination of dose within an irradiated phantom from ionization chamber measurements are in common use. One involves a determination of exposure in air and the application of conversion factors. The second involves the introduction of the ion chamber directly into the medium and a determination of exposure at that point followed by the application of conversion factors. For each of these methods a small attenuation correction must be applied to the exposure determination. The correction is commonly applied to ionization measurements made directly in the medium but is almost universally ignored when the reference exposure determination is made in air. (auth) (UK)

19318 INTERNAL CONVERSION COEFFICIENTS FOR ABSORBED DOSE CALCULATIONS. Widman, J. C.; Powsner, E. R. (Veterans Administration Hospital, Allen Park, Mich.). Phys. Med. Biol.; 15: 99-106(Jan 1970).

Internal conversion coefficients (K plus L plus M shells) and ratios of internal conversion coefficients (K to L plus M) have been tabulated in a form convenient for calculating absorbed dose from internally administered radioisotopes. (auth) (UK)

19319 NEW DATA ON RADIOACTIVE ISOTOPES. Zseboek, Z. B. (Hungarian Academy of Sciences, Budapest). Radiol. Aust.; 18: 53-6(1968). (In German).

Irradiation doses from clinical use of ^{131}I–human serum albumin (HSA), ^{72}As, ^{131}Ce, ^{85}Sr, and ^{87}Sr for radioisotopic studies were discussed. The lung irradiation dose from a single injection of 150 to 300 μCi of ^{131}I–HSA macroaggregates was from 150 to 200 mR.

Lung emboli were outlined as relatively ischemic areas, and tumors appeared as areas with diameter greater than 2 cm. Results with ^{131}I–macroaggregates were better than with ^{133}Xe because they could be given intravenously, while ^{133}Xe required inhalation as a gas. The disadvantage of using 500 μCi of ^{203}Hg for renal scans was that the kidney irradiation dose was 11 rad, while the whole-body dose was only 12 R. With ^{131}I–HSA the whole-body dose was only 0.4 R. Positron scanning was advantageous because it required only 15 min to complete, the intracranial hemodynamic relations were not disturbed, there was no danger of contamination, and it could be used before or after angiography and along with pneumoencephalography. When ^{72}As, that has a half life of 26 hr, was used, the whole-body dose was between 1 and 3 R. The kidneys were the critical organ. It differentiated between hypophyseal tumors, adenomas, and multipic metastatic lesions. The irradiation dose from 1 mCi of ^{131}Ce used for cardiac scanning was ~500 mrad. In doses of 100 μCi, ^{85}Sr gave whole-body irradiation doses of 0.6 R and bone doses of 2 to 4 R, while ^{87}Sr gave whole-body irradiation doses of only 2.4 mR and bone doses of 10 mR. (BBB)

19320 STUDY OF THE PHAGOCYTIC FUNCTION OF THE RETICULOENDOTHELIAL SYSTEM WITH RADIOACTIVE TRACERS AND THEIR DIAGNOSTIC APPLICATIONS. Gonzalez, M. T. Garcia. Acta Oncol.; 7: 1-41(Jan-Jun 1968). (In Spanish).

The dosimetry and retention of ^{198}Au administered to humans in 2 sizes of colloidal micelles after the phagocytic activity of the reticuloendothelial system was altered by various treatments were discussed. Retention of ^{131}I–labeled microaggregated albumin (MIAA) was also studied. The average dose of MIAA retained 4 hr after injection was 27.2%; of this, 64.6% was in the liver and 26% was in bone marrow. In 24 hr after injection of 6-mμ particles of radiocolloidal ^{198}Au, 91% of the radioactivity was retained, and of this 76.8% was detected in liver and 22.5% was in bone marrow. After 24 hr following injection of 35-mμ particles of radiocolloidal ^{198}Au, 95.2% was retained. Of this, 85.3% was in liver and 13.9% was in bone marrow. The liver irradiation dose calculated for the MIAA was 4.13 rad. For the 6-mμ ^{198}Au the liver dose was 278 rad, and for the 35-mμ particles it was 284 rad. In rabbits, the half times for liver deposition of the 6 and 35 mμ ^{198}Au were 64 and 38 sec, respectively. Following cortisone treatment, these values were decreased to 31 and 22.5 sec. (BBB)

19321 THE PROBLEM OF COMBINATION OF A RADIUM AND TELECOBALT TREATMENT FOR CERVICAL CARCINOMA. Kapp-Schwoerer, H. (Univ. Freiburg i.B.). Geburtsh. Frauenheild.; 29: 271-7(Mar 1969). (In German).

The problems of treatment and dose measurement of irradiation from Ra implants and telecobalt therapy of cervical carcinoma were discussed. The dosimeter used included a pneumatic chamber with fast readability of the instantaneous dose rate. The importance of preirradiation with ^{60}Co before implantation of Ra in order to reduce the dose of Ra required was emphasized. The Ra isodose pattern required accurate evaluation so that irradiation exposure of healthy tissue and organs could be kept as low as possible. This also improved the accuracy of the Ra treatment. The incidence of morbidity was decreased and fuller use of ^{60}Co γ irradiation was possible without increasing the total irradiation burden for the patient. (BBB)

19322 MICRODOSIMETRY OF IONIZING RADIATION. Zielczynski, M. (Inst. of Nuclear Research, Warsaw). Post. Fiz. Med.; No. 1, 57-61(1968). (In Polish).

Biological effects of irradiation depend upon the dose, i.e., the energy absorbed in the mass unity of tissue, and upon other factors such as the distribution of the imparted energy throughout the tissue. The linear energy transfer (LET) is an essential parameter of the biological effectiveness. Other parameters include the values of point dose, distribution of δ-electrons and distribution of stars. The methods applied in the investigations of the microdosimeter parameters are based on various principles, e.g., on the analysis of effects caused by separate particles in the analysis of global effects as well as in the recombination method and scintillation integral current method. In the global effect method the choice of the averaging procedure of the parameter investigated has an important influence on the results. The averaging procedures of the LET parameter are described. (auth) (NSA of Poland)

Radiation Protection

Refer also to abstract 19277.

19323 A STUDY ON RADIATION PROTECTION IN PRACTICE WITH SMALL ANIMALS (MEASUREMENTS OF RADIATION PROTECTION). Hartung, K.; Clauss, W. (Freie Univ., Berlin). Berlin. Muenchen. Tieraerztl. Wochenschr.; 80: 405-8(1967). (In German).

The international legal principles, and recommendations, and German laws and regulations concerning radiation protection for roentgen apparatus are discussed. Taking three methods of photography, the scattered ray fields were measured and thus the amount of radiation received by the operator was determined. The amounts thus evaluated showed that if care is taken to carry out the regulations governing radiation protection in veterinary practice the amount of radiation received will not exceed the amount considered as a safe limit. (auth)

19324 MEDICAL X-RAYS: BENEFIT VERSUS RISK. Neal, M. P. Sr.; Stickley, E. E. Virginia Med. Monthly; 96: 183-4 (Apr 1969).

Factors that affect radiation dose, hazards of x radiation during the practice of clinical radiology, and responsibilities of the physician to prevent excessive irradiation doses were discussed. The smallest radiation dose is given to the patient when equipment is in good condition, with carefully chosen exposure factors and fields as small as possible, with well-filtered radiation, and with ideal recording materials. Radiographic examinations should be done only because of a specific medical need. Casual use of the standard fluoroscope, without dark adaptation, subjects the patient to as much as 10 to 100 times the necessary levels of radiation and at the same time diminishes the information which the physician receives. Another cause of excess radiation is the repeat exposure which must be made when faulty techniques and equipment produces a film which is not diagnostic. The physician is responsible for his own training and adequacy, and is directly responsible for the proper training and performance of his staff. A person who positions the patient, exposes and develops the film, and sees to proper functioning of x-ray generating devices, dark-room chemicals, and all related factors must be fully trained and reliable. Paramedical personnel, in addition to training and consistent attention to adequate performance, must be highly motivated and mature to achieve routinely diagnostic x rays without extra radiation exposure. If the physician does not fully sustain his responsibility, a regulatory agency could intrude into his office to test, measure, and evaluate the way in which he carries out his practice, or they might subsequently direct the use of any radiant energy device that physicians or dentists may employ. (BBB)

Safety Procedures

19325 (MIT-952-6) RADIUM AND MESOTHORIUM POISONING AND DOSIMETRY AND INSTRUMENTATION TECHNIQUES IN APPLIED RADIOACTIVITY. Annual Progress Report. Evans, Robley D. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics). May 1969. Contract AT(30-1)-952. 383p. Dep. CFSTI.

Separate abstracts were prepared on five sections of this report. In these five sections, monitoring and toxicity investigations relating to uranium mining problems are discussed. The sections include: Radium and Mesothorium Toxicity in Human Beings; Dosimetry; General Radiobiology; Instrumentation Techniques; and Uranium Mine Dosimetry and Radiation Control. An appendix is included in the report listing the medical data of cases related to the project. (E.R.B.)

For abstracts of individual sections see: 19201, 19242, and 19286–19288.

Legal Aspects

Refer also to abstract 19314.

19326 MAXIMUM PERMISSIBLE DOSES OF RADIATION: THEIR CONCEPT AND APPLICATION. Dunster, H. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Brit. Nucl. Energy Soc.; 9: 41-4(Jan 1970).

The basis of radiological protection is the maximum permissible dose. This concept is discussed in terms of the likely relation between dose and risk of injury. The practical application of Maximum Permissible Doses and their extension to the concept of the derived working limit are discussed. Finally, an indication is given of the way these concepts can be converted to regulations or managerial instructions. (auth) (UK)

19327 REMINDER ON EMPLOYERS' RESPONSIBILITY UNDER RADIATION MONITORING ACT. Fortn. Rev. Chicago Dent. Soc.; 56: 8-9(15 Oct 1968).

An act of the State of Illinois was described to require employers to provide personnel radiation monitoring service acceptable to the

Department of Public Health for those employees subject to radiation, to report the personnel radiation exposure records furnished by such service, and to prohibit the operation of film badge radiation monitoring service without approval. The act provides that any employer of a person or persons subject to radiation monitoring requirements of the Department of Public Health would provide for each such person an acceptable type of personnel radiation monitoring service. Each such employer should maintain a record of the radiation exposure of each employee as reported by the monitoring service on prescribed forms and should forward such forms according to a prescribed schedule and at the termination of employment of any monitored employee. The record of each employee included the name and Social Security number of the employee. No person or firm should furnish a film badge radiation monitoring service in Illinois without approval from the Department of Public Health. Any person or firm providing such service on the effective date of this act could continue to provide such service without approval for not more than 6 months after the effective date. (BBB)

Medicine

Refer also to abstracts 19171, 19175, 19296, and 19369.

Protective Substances

Refer also to abstracts 19295 and 19347.

19328 STUDY OF THE THERAPEUTIC EFFECT ON IRRADIATED MICE OF SUBSTANCES CONTAINED IN RNA PREPARATIONS. Ebel, J. P. (Laboratoire de Chimie Biologique, Strasbourg); Beck, G.; Keith, G.; Langendorff, H.; Langendorff, M. Int. J. Radiat. Biol.; 16: 201-9(1969).

Preparations of various types of RNAs injected i.p. (2 to 5 mg/0.5 ml) before or after irradiation of mice with lethal or sublethal doses produce a significant increase in the survival rate. No difference in the therapeutic effect was observed between homologous RNA (from sucklings) and heterologous RNA (from rat liver or yeast). Extraction methods which favor the molecular integrity of the RNA give active preparations. However, the active substance seems not to be a polyribonucleotide nature although bound to substances in the RNA preparations since it is liberated during dialysis against water. The therapeutic effect does not seem to be related to the presence either of contaminating polypeptides or oligonucleotides. The activity of lipopolysaccharides is discussed. (auth) (UK)

19329 POST-RADIATION EFFECT OF HETEROAUXIN (INDOLEACETIC ACID) ON THE CELL AS A FUNCTION OF IRRADIATION DOSE. Araratyan, L. A. (Inst. of Experimental Biology, Erevan). Dokl. Akad. Nauk Arm. SSR; 48: 220-3 (1969). (In Russian).

Dry seeds of Allium fistulosum L. were given x-ray doses of 2.5, 5, 7.5, and 10 kR. Immediately after irradiation the seeds were put in a 50 mg/ml indoleacetic acid solution, and in water (controls). Rootlets 4 to 6 mm long were fixed 4 days after irradiation in a mixture of alcohol and acetic acid (3:1), and colored with acetocarmine for anaphase analysis of structural chromosomal rearrangements. Significant lowering of damaged chromosomes by indoleacetic acid treatment was noted only at a dose of 10 kR, where the percent of changed anaphases observed was 58.6% compared to a value of 84.0% in the controls. This protective effect of indoleacetic acid vanished if the seeds were not steeped immediately after irradiation. With a delay of only 10 minutes no difference from the controls could be observed. (TTT)

19330 POSTIRRADIATION HYPOXIA AND THE RECOVERY OF G_1 AND G_2 CELLS AND DNA SYNTHESIS IN CULTURED ROOT MERISTEMS. Van't Hof, J. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 41: 538-51(Mar 1970).

Recovery after a 300 R dose of γ rays by G_1 and G_2 stationary phase meristematic cells of cultured pea roots was measured under aerobic and hypoxic culture conditions. The recovery indices used were the initiation of DNA synthesis by former G_1 cells, the rate of DNA synthesis when the G_1 cells were subsequently in S, and the appearance of G_2 cells in mitosis. The results showed that G_1 and G_2 cell recovery was confined to the period occupied by the cell at the time of irradiation and that the subsequent transit of S and G_2 was performed at rates equivalent to that of the unirradiated control. They also revealed that the duration of delay was equal for G_1 and G_2 cells when the postirradiation conditions were aerobic. When the postirradiation conditions were hypoxic, the recovery of G_1 cells was not impaired while that of the G_2 cells was greatly reduced. DNA synthesis by former G_1 cells generally reflected the extent of recovery determined cytologically. The one exception was an unusually accelerated ^{3}H-T incorporation rate presumably induced by a 24-hr preincubation under nitrogen. The mechanism responsible for this increased rate was radiosensitive and did not recover under hypoxia. (auth)

Radiodiagnosis

Refer also to abstracts 19196, 19211, 19216, 19219, 19221, 19222, 19319, and 19324.

19331 MEDICINSKA ISOTOPMAETNINGAR. (Radioisotope Measurement in Nuclear Medicine). Low, Frank H.; Cederlund, Jan. Scandinavian University Books. Stockholm; Svenska Bokfoerlaget (1969). 103p.

The book is a translation to Swedish of Radioisotope Measurements in Nuclear Medicine by Frank H. Low published by the Picker X-Ray Corporation. (Sweden)

19332 LIVER SCINTISCANNING. Davies, E. Rhys (United Bristol Hospitals, Bristol, Eng.). Proc. Roy. Soc. Med.; 62: 796-8(Aug 1969).

The accuracy and limitations, the relative merits of the methods available, the abnormalities that can be detected, and the clinical problems to which they can be applied were discussed for ^{99m}Tc-sulfur colloid when used in liver scintiscanning. The disadvantages of using ^{131}I-labeled rose bengal and bromsulalein to measure polygonal cell uptake were discussed. For measurement of Kupffer cell uptake of colloids, ^{99m}Tc-colloid has been more favored than ^{198}Au colloid or ^{131}I-labeled human serum albumin. Recently ^{113}In colloid has been introduced, but has not yet been evaluated fully. All these compounds were removed by reticuloendothelial cells, and apart from labeled albumin, which is broken down, they were retained by them. None was excreted in the bile. Up to 85% of the total injected was concentrated in normal liver. Most of the remainder was concentrated by the spleen with a very small amount in bone marrow. Indications for liver scintiscanning included distinguishing localized lesions from diffuse abnormalities, in known liver disease, differential diagnosis of upper abdominal masses, detecting occult metastases, localizing known or suspected lesions following up the results of treatment, and investigation of jaundice. It was concluded that scintiscanning is a simple method of assessing the size, shape, and position of the liver, and is an accurate way of determining the site and distribution of intrahepatic lesions, particularly those that are localized. It has few limitations and most of these can be overcome by combining its use with other methods of investigation, notably ultrasonic scanning. (BBB)

19333 ISOTOPE TECHNIQUE FOR MEASURING LACTOSE ABSORPTION. Salmon, P. R.; Read, A. E.; McCarthy, C. F. (Royal Infirmary, Bristol, Eng.). Gut; 10: 685-9(Aug 1969).

An isotope method was developed and a simply constructed apparatus designed to collect and measure expired radiocarbon dioxide for routine clinical use. By using this method good separation of normal from lactase-deficient subjects is achieved by analysis of the cumulative record of labeled carbon dioxide exhalation. The expired carbon dioxide is collected by an autotitration method following the ingestion of lactose-1-^{14}C. With this method, 12 subjects with alkalosis were readily separated from 24 normals, both groups being defined by strict criteria. This test, which may be used to measure the absorption of other sugars, is especially suitable for population surveys and may be used to investigate the distribution of disaccharidase deficiency. A further advantage is that false low readings resulting from rapid plasma clearance of absorbed sugar do not occur with this method although they may do so in lactose tolerance tests, thereby overestimating the prevalence of alactasia. (BBB)

19334 PANCREATIC SCINTIGRAPHY BY ELECTRONIC SUBTRACTION. Blanquet, P.; Dubarry, J.-J.; Beck, C.; Pigneux, J.; Lebras, M.; Hecquet, M.-F. (Hopital Saint-Andre, Bordeaux). Presse Med.; 77: 1237-40(Aug-Sep 1969). (In French).

A method of electronic subtraction scintigraphy to differentiate deposition of 200 μCi of ^{75}Se-labeled selenomethionine in pancreas from deposition of 200 μCi of ^{198}Au in liver is discussed. In order to correct for the deposition of ^{75}Se in liver after administration as labeled selenomethionine, ^{198}Au, which was deposited in liver only, was administered simultaneously. The radioactivity localized in liver due to the ^{198}Au was measured and subtracted electronically to correct for the portion of ^{75}Se-selenomethionine in the liver, and thus to delineate the ^{75}Se more clearly. Similar studies were performed with 200 μCi of ^{131}I-labeled erythrocin B, which localized in both liver and spleen, and 750 μCi of ^{99m}Tc-sulfide, which localized in the liver only. These studies were performed

on 21 patients, but the combination of ^{75}Se and ^{198}Au was used in 179 patients. Some of the ^{75}Se was observed in the intestinal walls. In order to help increase the pancreatic deposition of ^{75}Se, some of the patients were given protein supplements or perfused with glucose solutions. Anticholinergic agents such as probanthine or glutamic acid were also given shortly after administration of the ^{75}Se and ^{198}Au. The course of accumulation of ^{75}Se and ^{198}Au in normal patients and patients with pancreatic defects was compared, and morphological differences were described. The normal pancreas had a variable shape, but the shadow was always homogeneous and well delimited. In chronic pancreatitis and carcinoma, filling defects were noted, but were not pathognomonic. Slow uptake, filling defects, and marked intestinal uptake were often noted in chronic pancreatitis. (BBB)

19335 INHALATION LUNG SCANNING EVALUATION: RADIOAEROSOL VERSUS RADIOXENON TECHNIQUES. Shibel, Elaine M.; Landis, Glen A.; Moser, Kenneth M. (Georgetown Univ., Washington, D. C.). Dis. Chest; 56: 284-9(Oct 1969).

A comparison was made of the visual display of the distribution of pulmonary perfusion via photoscanning, using different radionuclides, including macroaggregated albumin (MAA) labeled with ^{131}I or ^{99m}Tc, and ^{133}Xe gas injected intravenously. Perfusion scans were performed by intravenous injection of ^{131}I-MAA. Inhalation scans were done using ^{99m}Tc-albuminate in saline solution, 5 mCi in 5 to 10 ml, which was nebulized. For radioxenon scans, 25 mCi of gaseous ^{133}Xe was introduced by a spirometer along with 5l of 100% O_2. The ^{131}I-MAA perfusion scans and ^{99m}Tc-albuminate inhalation scans were taken in posteroanterior (PA), anteroposterior (AP), and both lateral projections. The ^{133}Xe scans were taken only in the PA projection. Normal subjects and patients with pulmonary disease were studied. Particle inhalation in normal controls revealed adequate peripheral filling, although upper airway and gastrointestinal deposition occurred. In patients with pulmonary disease, however, underventilated zones of lung appeared totally unventilated with particle scans, while those with ^{133}Xe gas reflected ventilation disturbances more accurately. Furthermore, a dynamic visualization of ventilation could be obtained using ^{133}Xe, while scans with ^{99m}Tc-albuminate indicated the cumulative result of several minutes of positive pressure breathing. It is concluded that both methods can offer important information, but each has its own limitations and advantages which should be recognized. (BBB)

19336 COMPARISON OF WHOLE-BODY LIQUID SCINTILLOMETRY, RADIOGRAPHY, AND CLINICAL CHEMICAL TESTS IN THE EVALUATION OF THE EFFECT OF CHRONIC CORTICOID DOSING ON CALCIUM IN BEAGLES. Bhatti, M. C.; Shaw, S. M.; Lewis, R. E.; Christian, J. E. (American Animal Industries, Indianapolis). J. Pharm. Sci.; 59: 368-71(Mar 1970).

Chronic doses of 6α-methylprednisolone were administered to beagles for 106 days to bring about changes in calcium balance. During the initial 64 days of corticoid treatment, no outstanding changes were observed in the blood levels of calcium, phosphorus, or alkaline phosphatase. Radiographic changes in the skeleton were not seen after 64 days of treatment. Significant changes in ^{47}Ca retention were detected by whole-body liquid scintillometry after only 13 and 28 days of corticoid administration. On day 64 of the study, the dosage of 6α-methylprednisolone was increased. Decreased levels of calcium in blood plasma and increased levels of plasma alkaline phosphatase were observed after the dose of corticoid was increased. A great reduction in whole-body ^{47}Ca retention was also observed, and thinning of the cortices of the long bones of the legs was apparent. The results of the investigation indicate that whole-body liquid scintillation counting of ^{47}Ca is a sensitive indicator of alterations of calcium metabolism in relation to other diagnostic methodology. (auth)

19337 ISOTOPNEPHROGRAPHIC STUDIES IN ORTHOSTATIC-PROTEINURIC CHILDREN. Siegler, J.; Marosvari, I.; Dekany, K. (Univ. Budapest). Monatsschr. Kinderheilk.; 117: 531-5(Aug 1969). (In German).

Renal nephrography with ^{131}I-labeled Hippuran was used in 23 children suffering from orthostatic proteinuria to detect and study renal anatomical or functional defects. The results of these studies were compared subsequently with pyelograms. One of the main advantages of the renal nephrographic studies was that the irradiation dose was only from $1/_{300}$ to $1/_{100}$ of the dose that was received from an intravenous pyelogram. In addition, the irradiation dose could be decreased to levels even below the ^{131}I dose when ^{125}I-Hippuran was used. It was felt that if the ^{131}I nephrogram was normal, it was not necessary to perform an intravenous pyelogram on the patients. In this way additional irradiation of some of the patients was avoided. Because the ^{131}I nephrogram irradiation dose was so low it was recommended that ^{131}I nephrography would facilitate serial studies in orthostatic proteinuric patients without imposing a large irradiation burden. (BBB)

19338 EVALUATION OF GLOMERULAR CLEARANCE IN THE WHOLE-BODY COUNTER WITH MINIMAL QUANTITIES OF A RADIOINDICATOR. Romahn, A.; Oberhausen, E.; Kirsch, W. (Univ., Homburg, Ger.). Monatsschr. Kinderheilk.; 117: 365-7 (Apr 1969). (In German).

A method for evaluation of glomerular clearance in children by whole-body counting of ^{51}Cr-ethylenediaminetetraacetate for times as short as 100 sec was described. One of the major advantages of the procedure described was the small irradiation burden that resulted from the method. The retention curve for ^{51}Cr measured in an infant gave accurate values for the glomerular clearance. A comparison in 18 adults of the results obtained from the method described with those obtained from the classical inulin method showed very good agreement. In addition to the decreased irradiation received by the patients, the whole-body counting method had the advantages that it required only a single injection, was completed within a short time, and required no infusions, equilibration time, or catheterization. (BBB)

Radiotherapy

Refer also to abstracts 19136, 19247, 19321, 19366, 19367, 19372, and 20294.

19339 COMBINED TREATMENT FOR CANCER OF THE HYPOPHARYNX: A PRELIMINARY REPORT. Cox, Robert H. (Ochsner Clinic, New Orleans). S. Med. J.; 62: 929-30(Aug 1969).

Problems encountered in the radiotherapy of pharyngeal neoplasms are considered, and an improved method combining ^{60}Co γ irradiation with surgery is reported. In the past decade a gradual change has occurred in the treatment of carcinoma of the hypopharynx. The most popular treatment formerly consisted of radical resection of the primary site along with a unilateral or bilateral neck dissection. Sometimes the radical surgery was followed by conventional x-ray therapy. Postoperatively, the blood supply to the surgical field was reduced, thereby creating problems in giving x-ray therapy to the area. Therefore, many radiologists refused to give postoperative irradiation unless residual tumor was present or a recurrence developed, and when it was used it was seldom effective. The amount of preoperative x-ray treatment given has depended on the individual radiologist, but the usual range varied from 2000 to 5500 R. An upper limit was placed on the amount used to reduce serious postoperative complications such as rupture of the carotid artery and fistulas. When ^{60}Co was used instead of conventional therapy, marked improvement in the primary site became noticeable. It was decided to apply a full therapeutic dose to the tumor area and treat the cervical lymphatics at the same time. When the treatment was completed, the patient was given a rest period of 2 months so the acute tissue reactions had time to subside. Another biopsy was performed in 2 months to determine the status of the primary site. If the biopsy was negative for malignant cells, a radical neck dissection was done within the next 2 days. Of the 13 cases presented, 9 are living and well, 3 patients had recurrences, and 1 patient died from an unrelated disease. (BBB)

19340 HIGH-VOLT THERAPY IN NEOPLASMS OF THE PARA-AORTAL AND MEDIASTINAL LYMPHATIC SYSTEM. Kuttig, H. (Univ., Heidelberg). Radiol. Aust.; 18: 181-7(1968). (In German).

The advantages and methods of using high-voltage irradiation therapy for para-aortal and mediastinal lymph system neoplasms were discussed. The necessity to avoid excessive irradiation of the abdominal area because of the radiation sensitivity of the bone marrow was indicated. For large irradiation fields the tolerance of the bone marrow was close to 3500 R given in 17 days, or a biologically equivalent dose of 3900 to 5000 R in 28 days. Other radiosensitive organs include the kidneys and the intestinal mucosa. In the thoracic area the bone marrow and the lung parenchyma were the most radiosensitive. Irradiation injuries observed in these areas have indicated the need for improvement in irradiation procedures even with megavolt therapy by techniques such as moving irradiation and sieve irradiation. It was found that use of two opposite fields of ^{60}Co teletherapy was not especially advantageous, but dose distribution was improved if a third field was used with wedge filters, and the bone marrow dose was only from 70 to 90% of the maximum dose. When bisegmental pendulum irradiation was used, the disadvantage was that the kidneys received relatively high irradiation doses. (BBB)

19341 RESULTS OF RADIOHYPOPHYSECTOMY FOR METASTATIC CANCER OF THE BREAST AS RELATED TO SEX CHROMATIN. Wense, G. (Univ., Vienna). Arch. Klin. Chir.; 323: 339-44(1969). (In German).

Effects of chromatin structure on the success of radiohypophysectomy with ^{90}Y were studied in patients with metastatic mammary carcinomas. Out of 17 patients with sex chromatin-positive tumor cells, 14 showed improvement after ^{90}Y treatment by decreased pain symptoms. Only four out of 16 patients with sex chromatin-negative tumor cells exhibited less pain after ^{90}Y radiohypophysectomy. Only 33% of all patients with painful metastases from mammary carcinoma responded favorably to ^{90}Y radiohypophysectomy. Adenocarcinomas responded better than other histological types. Various other tests that indicated a good probability of successful treatment of metastatic mammary carcinoma with ^{90}Y radiohypophysectomy included a decreased excretion of Ca after testosterone treatment, increased Ca excretion and reduced pain after treatment with estrogen, decreased 17-hydroxy steroids accompanied by increased urinary excretion of androgenic metabolites, and decreased urinary Ca excretion along with decreased pain symptoms observed after cortisone administration. It was concluded that there was no simple relation between ^{90}Y radiohypophysectomy and the sex chromatin structure of the tumor cell nuclei. (BBB)

19342 APROPOS OF A RARE FORM OF ONDONTO-RADIONECROSIS. Friez, P.; Alexandre, Et.; Lesage, Cl.; Marie, J. L. Acta Stomatol. Belg., 65: 459-500(1968). (In French).

The clinical and radiographic features of radioinduced necrosis of the mouth are reviewed. A case of radioinduced necrosis following ^{60}Co γ therapy of a glosso-epiglottic tumor is described. It is emphasized that total extraction of teeth should precede radiotherapy of mouth lesions if the radiation field includes the jaw bones. (C.H.)

Blast and Thermal Effects

19343 BONE TUMORS AMONG THE ATOMIC BOMB SURVIVORS OF HIROSHIMA AND NAGASAKI. Yamamoto, Tsutomu; Wakabayashi, Toshiro (Atomic Bomb Casualty Commission, Hiroshima). Acta Pathol. Jap.; 19: 201-12(May 1969).

Benign and malignant bone tumors found at autopsy and in surgical specimens in Hiroshima and Nagasaki during the period 1950 to 1965 were studied to determine whether or not there is a relation between atomic bomb radiation and formation of bone tumors. A total of 163 bone tumors was found in both cities at autopsy, and 133 in surgical specimens. There were 76 malignant tumors and 87 benign tumors. Multiple myeloma and osteosarcoma (26 cases each) together constituted 70% of the malignant tumors, and osteochondromas and enchondromas accounted for 70% of the benign tumors. Of the 76 malignant tumors found, only 25 were in survivors, the remaining 51 benign in persons who were not in the cities at the time of the bombing. Of the 25 malignant tumors found in survivors, only five were in persons who were within 1400 m of the hypocenters. The prevalence rate for malignant bone tumors in the autopsies in the fixed sample was estimated to be 0.26%. No direct relation was found between the frequency or type of bone tumor and exposure distance. The case histories of five proximally exposed persons who died of malignant bone tumors (2 osteosarcoma and 3 multiple myeloma) are presented. (BBB)

Radiation Effects on Animals

Refer also to abstracts 19260, 19296, 19298, 19310, and 20278.

19344 THE DETECTION OF IONIZING RADIATION DAMAGE IN ERYTHROCYTE SOLUTIONS BY ULTRASOUND. Woodcock, J. P.; Allsop, C. B. (Guy's Hospital Medical School, London). Acustica; 22: 115-20(1969-70).

Ionizing radiation damage can be detected in erythrocytes in solutions by ultrasonic absorption techniques. At dose levels of the order of 42,000 rads x radiation, ultrasonic absorption techniques indicate that the primary radical attack is on the erythrocyte membrane. (auth)

19345 TIME-LAPSE CINEMICROGRAPHIC STUDIES OF X-IRRADIATED HeLa S3 CELLS. II. CELL FUSION. Hurwitz, Camilla; Tolmach, L. J. (Washington Univ., St. Louis). Biophys. J.; 9: 1131-43(Sep 1969).

Analysis of time-lapse cinemicrographs of x-irradiated HeLa S3 cells has shown that the incidence of cell fusion was increased from 0.9% following 1267 divisions in control cells to an average of 22% following 655 divisions in cells irradiated with 500-rad doses of 220 kV x rays. The incidence depended on the stage of the generation cycle at which the parent cells were irradiated. It was nearly constant in the first three postirradiation generations. Fusion occurred at all stages of the generation cycle, but preferentially during the first 20%. Cells undergoing fusion progressed more slowly through the generation cycle and had a higher probability of disintegrating than did irradiated cells that did not fuse. The occurrence of fusion was clonally distributed in the population. It took place only between sister or closely related cells. Protoplasmic bridges were often visible between sister cells prior to fusion. Giant cells arose only as a result of fusion. The incidence of multipolar divisions, though higher than in unirradiated cells, was only 5.5% in cultures irradiated with 500 rad. Fusion occurred following 85% of the multipolar divisions and was often followed by a multipolar division. (auth) (BBB)

19346 RELATIONSHIP BETWEEN THE MORTALITY OF WHOLE ANIMALS AND THE SURVIVAL CURVE FOR SINGLE CELLS. Gilbert, C. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 16: 287-90 (1969).

In biological systems where the action of radiation or drugs sterilizes a proportion of a group of sensitive and critical cells it is suggested that the dependence of the differential mortality of the organism on the remaining number of viable cells can be given by an empiric log-normal curve with two adjustable parameters. The mortality curve for the organism can then easily be obtained from the survival curve for the sensitive cells. (auth)

19347 DNA REPAIR IN CHINESE HAMSTER CELLS OF DIFFERENT SENSITIVITIES TO ULTRA-VIOLET LIGHT. Cleaver, J. E. (Univ. of California, San Francisco). Int. J. Radiat. Biol.; 16: 277-85(1969).

An altered Chinese hamster cell-line, V7979, derived from line V79 by irradiation with 1500 R of x rays, is more sensitive than the parent to killing by uv light (V79, $n = 1.6$, $D_0 = 43$ erg/mm^2; V7979, $n = 1.3$, $D_0 = 30$ erg/mm^2). Ultraviolet light inhibits DNA synthesis to the same extent in both cell-lines up to 11 hours after irradiation. Both cell-lines perform unscheduled synthesis, but the V7979 performs less than the V79. The amount of unscheduled synthesis is thus correlated with survival in these two closely related cell-lines. Unscheduled synthesis may therefore represent DNA repair which contributes to the recovery of uv-damaged cells. (auth)

19348 THE METABOLIC REQUIREMENTS FOR REPAIR OF SUBLETHAL RADIATION DAMAGE. Ashby, Regina Roux. Dallas; Univ. of Texas (1969). 67p.

Thesis.

The recovery of Chinese hamster cells grown in tissue culture and incubated between two doses of x radiation in full medium was demonstrated. When asynchronous populations of Chinese hamster cells were incubated between two doses in balanced salt and glucose, survival fractions equal to those in full medium were obtained. Incubation of cells in complete medium containing concentrations of sodium fluoride, inhibitory to glycolysis in many systems, had no effect on recovery. However, concentrations of sodium fluoride that were not toxic to cells over the period of experiment inhibited repair in the presence of balanced salt and glucose during the recovery period. Sodium fluoride is known to inhibit the step in glycolysis from 2-phosphoglycerate to phosphoenol pyruvate by forming a magnesium-fluoro-phosphate complex with the enzyme catalyzing this step in glycolysis, enolase. This inhibition can be bypassed by the addition of alanine to the system containing balanced salts and glucose plus sodium fluoride. Alanine can be converted to pyruvate and enter the citric acid cycle to provide energy. Alanine also can be substituted for glucose. These results suggest that a source of energy is required for repair. When glucose was the only exogenous source of energy, sodium fluoride blocked the entry of pyruvate into the citric acid cycle. In full medium, other medium components could enter the citric cycle and supply energy. Thus, the minimum metabolic requirements for the repair of sublethal radiation damage for Chinese hamster cells was balanced salt solution and source of energy. (Diss. Abstr.)

Vertebrates

Refer also to abstracts 19282, 19295, 19299, 19300, 19303–19308, and 19328.

19349 INDIVIDUAL DIFFERENCES IN THE STRESS RESPONSE OF MICE AND THEIR RELATIONSHIP TO THE DIFFERENCES IN RADIATION TOLERANCE. Vacha, J.; Pospisil, M. (Inst. of Biophysics, Brno). Med. Exp.; 19: 58-63(1969).

The relation between the intensity of a stress response in mice, as manifested by the extent of interindividual variability, and differences in tolerance to multiple sublethal doses of x radiation,

was studied. Weekly blood withdrawal and 24-hr isolation and starvation of the animals constituted a nonspecific stress. The decline in the peripheral leukocyte count was used as an indirect indicator of interindividual differences in the activation of general adaptation syndrome. The total number of exposures preceding death was chosen as a measure of radiation tolerance of individual animals. After 9 blood withdrawals, the animals were x irradiated every 3rd day by a whole-body dose of 200 R. All animals of the stressed group displayed an irregular decrease in repeatedly measured leukocyte counts (the average was 14,860 at the start of the experiment and 5820 leukocytes/mm^3 at the end). The highest radiation tolerance (within the range of the variability of the group) was exhibited by individuals with a moderate stress response in the leukocyte level, which is interpreted as indicating the existence of a regulatory optimum, satisfying most adequately the needs of the animal under stress conditions. The extreme variants of stress response are accompanied by a higher sensitivity to irradiation. It is possible that a moderate stress response enhances the resistance of mice to irradiation. Several individuals of the stressed group exhibited a higher resistance to irradiation, compared with the tolerance range for individuals of the control group. (BBB)

19350 CHROMOSOME ABERRATIONS AND OTHER EFFECTS PRODUCED BY ^{90}Sr–^{90}Y IN CHINESE HAMSTERS. Brooks, Antone L.; McClellan, Roger O. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Int. J. Radiat. Biol.; 16: 545-61(1969).

Chinese hamsters were injected with 0, 0.2, 0.5, 1.0, 2.0, 3.0, and 5.0 μCi of ^{90}Sr–^{90}Y/g body-weight and sacrificed at 2, 14, 28, 56, 113, and 224 days after injection to assess the biological damage. The 3.0 and 5.0 μCi injections produced deaths by 10 days after injection, whereas with 1.0 and 2.0 μCi, most early deaths occurred at 120 to 180 days and 40 to 80 days, respectively. In all cases, death appeared to be related to total accumulated radiation dose and cellular depletion of the bone marrow. Changes in bone-marrow cells at each time-point included an increase in number of chromosome breaks/cell as a function of dose accumulated at the time of death, and a response of the bone-marrow mitotic index that reflected an increase above control levels with a low total dose and a decrease as the dose passed a critical point. The number of chromatid plus isochromatid deletions increased with increased injected activity and dose-rate, and the relative frequency of chromosome exchanges increased with time. Examples of cellular cloning were noted. (auth) (UK)

19351 THE ENTERIC SITUS OF THE ALPINE SALAMANDER (TRITURUS ALPESTRIS) AFTER UV IRRADIATION IN PREGASTRULA STAGES. Kraft, Arne v. (Heiligenberg- Institut, Ger.). Arch. Entwicklungsmech. Organ.; 163: 178-83(30 Jul 1969). (In German).

Uncleaved eggs and eggs with 4, 32, or 64 blastomeres and blastulae of Triturus alpestris were irradiated with mixed uv light. The irradiations were one-sided without diaphragm, in the animal or vegetative region, or perpendicular to the animal-vegetative region in the equatorial plane. The irradiation times ranged from 15 to 20 min. The relative percent of visceral inversions produced in various pregastrular stages was measured. Visceral and cardiac inversions were not increased by the irradiations. After irradiation of young gastrulae where the vegetative region with the blastopore was exposed, there was some increase in visceral inversions. The uv irradiation of gastrula, neurula, and postneurular stages was observed to produce inversions proportional to irradiation dose, that were related to the region irradiated. The studies reported indicated how the subsequent asymmetry of the larva was preformed during the earliest germinative stages by microstructural asymmetries. (BBB)

19352 SENSITIVITY OF RATS TO MERCURY BICHLORIDE AFTER A SINGLE 400-R DOSE OF IRRADIATION. Dolgov, E. G.; Oraibaev, K. O. (Medical Inst., Semipalatinsk, USSR). Farmakol. Toksikol.; 32: 219-20(Mar-Apr 1969). (In Russian).

Resistance to mercury bichloride toxicity was studied in rats exposed to a single 400 R dose of 170-kV x rays. After one, three, five, seven, 10, and 20 days 15 test and 15 control animals were given subcutaneous injections of 7.5 mg/kg sublimate. This resulted in a bimodal mortality pattern as evaluated over the next 20 days, with highest frequency of deaths at seven to 10 days. Resistance to Hg toxicity was determined on the basis of average survival time of each group. Radiation-caused inhibition of thiol enzymes decreased after 20 days. Any induced increase or decrease of tissue SH group content evidently effects animal resistance to ionizing radiation. It is suggested that because sulfhydryl groups are the binding site for Hg compounds, the toxic effects of Hg and ionizing radiation combine to inhibit enzyme systems which are dependent on thiol groups for activity. (BBB)

19353 CYTOGENETIC STUDY OF LYMPHOID LEUKEMOGENESIS IN ISOGENIC RADIOCHIMERA AKR-T1ALD MICE. Legrand, Elisabeth; Duplan, Jean-Francois (Radium Inst., Paris). Compt. Rend., Ser. D, 268: 2990-2(June 16, 1969). (In French).

X radiation stimulates the process of spontaneous leukemogenesis in AKR mice. The study of the caryotypes of the bone marrow and of the thymus of T1ALD mice injected with bone marrow from x-irradiated AKR mice and subsequently exposed to fractionated doses (four irradiations of 175 R) of x radiation showed that the development of leukemia of the donor type was much slower than that of the receiver type. Some animals showed multiclonal leukemia and thymus gland lymphosarcomas containing a mixture of donor and receiver chromosomes. (C.H.)

19354 ASSESSMENT OF RAT THYROID AS A RADIOBIOLOGICAL MODEL. THE EFFECTS OF X-IRRADIATION ON CELL PROLIFERATION AND DNA SYNTHESIS IN VIVO. Greig, W. R. (Royal Infirmary, Glasgow); Smith, J. F. B.; Duguid, W. P.; Foster, C. J.; Orr, J. S. Int. J. Radiat. Biol.: 16: 211-25(1969).

The cell population of the adult rat thyroid gland shows very little proliferation as measured by sequential changes in thyroid weight, cell density, chemical DNA and RNA and by total uptake of tritiated thymidine (^3H-T) into cell DNA or by cell-labeling indices (L.I.). In contrast, administration of a continuous goitrogenic challenge (0.1 percent methylthiouracil as drinking fluid and a low iodine diet) induces, after a lag phase of 2 days, a 2 to 3-fold increase in thyroid weight, the maximum weight being attained within 28 days of the goitrogenic challenge. During thyroid growth the cell density falls about 10 percent; chemical DNA rises with gland weight but slightly less than chemical RNA; and both the uptake of ^3H-T and L.I. parallel the rate of change of DNA content. Doses of 100, 500, or 1000 rads x rays given to the normal rat thyroid produce latent cell damage; there is an impairment of weight increase during a subsequent goitrogenic challenge, related to the dose of x rays; irradiation has no influence on cell density but results in a 2 to 3-fold increase above control values in both the uptake of ^3H-T and L.I. The peak uptakes of ^3H-T and L.I. after irradiation are not clearly dose-dependent, but they do coincide with the time when thyroid growth is arrested or slowed by previous irradiation. The rat thyroid, growing under the influence of a 28-day goitrogenic regime is a closed dividing population. If allowance is made for initial weight and the weight increase not due to cell division, the system can be used to measure the effects of irradiation on mammalian thyroid cell survival in vivo. Special features of the system include an intrinsic restricted capacity of the cell population to undergo more than an average of one or two divisions and the advantage that stromal cells may be distinguished from follicular cells. Evidence is produced to suggest that stromal cells might be more radioresistant than follicular cells. The increased peak rate of DNA synthesis in x-irradiated rat thyroid in which growth is promoted by a goitrogenic challenge appears to be due to the accumulation of cells damaged in G_1 at S-phase. The cells appear to accumulate because the generation time is slowed and because of their built-in restricted capacity to multiply. (auth)

19355 ADRENOCORTICOTROPIC HYPOPHYSIS FUNCTION DURING AN ACUTE RADIATION SYNDROME IN THE EXPERIMENT. Bezbrodnyi, Yu. V. (Inst. of Medical Radiology, Obninsk, USSR). Med. Radiol.; 14: No. 10, 63-72(1969). (In Russian).

A brief review is given on adrenocorticotropic function of the hypophysis during acute radiation sickness in guinea pigs, mice, and rats. The synthesis and secretion of ACTH were changed significantly during the first stages of sickness; this was confirmed by the biological determination of ACTH in the hypophysis, in blood, and by direct studies of ACTH synthesis in the hypophysis. However, secretion of ACTH during acute stages could not be established. The metabolism of ACTH during the initial development of radiation syndrome did vary within the first hours after exposure. Disturbances in the hypothalamic regulation of the ACTH function were assumed to be quite probable; however, direct data for confirming the postulation were not available. It was suggested that the central nervous and peripheral functions of the ACTH behavior should be further examined in studies of radiation endocrine syndrome. (R.V.J.)

19356 RESPONSE OF SINGLE MOUSE LYMPHOMA CELLS TO X-RAYS BY EFFECTIVE FRACTION METHOD IN VIVO. Maruyama, Yosh; Ceman, C. (Univ. of Minnesota Hospitals, Minneapolis). Radiat. Res.; 41: 522-67(Mar 1970).

An x-radiation survival curve was determined for a syngeneic mouse lymphoma, the LSA tumor of C57BL mice, using the effective fraction method. The effective fraction behaves as a unit, most likely a single tumor cell capable of transferring the neoplasm to isogeneic recipients. The survival curve parameters showed a D_0 of 103 R, and an extrapolation number of 5.0, and were consistent with TD50 results, obtained at the same time. Dose-dependent increase in recipient survival time was found consistent with small colony observations reported for irradiated cultured cells. It was found that seven cells on the average will contain one effective cell assayed by its ability to produce tumors in 63% of recipient animals. (auth)

19357 THE ACUTE MORTALITY RESPONSE OF THE MINIATURE PIG TO PULSED MIXED GAMMA-NEUTRON RADIATIONS. Wise, David; Turbyfill, Charles L. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.; 41: 507-15(Mar 1970).

Miniature pigs were exposed unilaterally to mixed γ-neutron radiations from the AFRRI-TRIGA reactor delivered in a single pulse. Seventy-one miniature pigs received midline tissue doses ranging from 183 to 335 Rads. The $LD_{50(30)}$ was 218 Rads. Survival times ranged from 10 to 22 days, and the mean survival time for all decedents was 15.1 days. Clinical symptoms and pathological changes are reported. (auth)

19358 NEONATAL IRRADIATION AND POSTNATAL BEHAVIOR IN MICE. Nash, Donald J.; Napoleon, Arnold; Sprackling, Le Etta (Colorado State Univ., Fort Collins). Radiat. Res.; 41: 594-60(Mar 1970).

Postnatal behavior as measured by activity and elimination in the open field, activity in exercise wheels, and hoarding performance, was followed in mice of the ENA strain that were exposed to 300 R x rays on the day of birth. Long-lasting effects of neonatal irradiation were evidenced by changes in several characteristics. Irradiated mice weighed only 87% as much as controls at 7 weeks of age. Neonatal irradiation decreased elimination scores, activity in wheels, and hoarding scores, but did not have a significant effect on open-field activity. Additional studies examined the relation between locomotion in the open field and different levels of neonatal irradiation in three genotypes of mice. In general, locomotion decreased with increasing levels of irradiation in the three genotypes, with all three genotypes showing a marked decrease after receiving 300 R. Comparison of present results with those of other studies demonstrated that strain differences may influence the type of behavioral response observed after neonatal irradiation. (auth)

19359 SURVIVAL OF MOUSE SKIN EPITHELIAL CELLS FOLLOWING SINGLE AND DIVIDED DOSES OF X-RAYS. Emery, E. W.; Denekamp, J.; Ball, M. M. (Hammersmith Hospital, London). Radiat. Res.; 41: 450-66(Mar 1970).

A slight modification of Withers' technique was used to study the survival of mouse skin epithelial cells after using single doses and divided doses of x rays with intervals up to 21 days between fractions. The general features of Withers' results were confirmed, but the doses used for the same effect were higher. The single-dose survival curve had a D_0 of 135 Rads; the dose increment required to compensate for a 24 hr interval between fractions was 570 Rads. The increase of $D_2 - D_1$ with time after 24 hr leads to an estimate of the doubling time of surviving cells of not less than 36 hr compared with Withers' value of 22 hr. There is evidence of a considerable spread in the proliferation rate of surviving cells. The probability of epithelial regrowth was shown to be independent of subdivision of the test area, in accordance with the hypothesis that regrowth can take place from a single cell. (auth)

19360 LATE EFFECTS OF FAST NEUTRONS AND GAMMA-RAYS IN MICE AS INFLUENCED BY THE DOSE RATE OF IRRADIATION: INDUCTION OF NEOPLASIA. Upton, A. C.; Randolph, M. L.; Conklin, J. W. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 41: 467-91(Mar 1970).

The influence of dose and dose rate on the oncogenic effectiveness of 1-MeV neutrons, 5-MeV neutrons, 250-kVp x rays, and ^{60}Co γ rays was investigated in male and female RF mice exposed to various doses of whole-body radiation at dose rates of 10^{-6} to 10^{2} Rads/min, beginning at 10 weeks of age. Incidence of myeloid leukemia and of the thymic lymphoma increased with dose, also varying with dose rate of γ rays but not of neutrons. Neutrons were equally or slightly less leukemogenic than x or γ rays at high dose rates but several times as leukemogenic as γ rays at low dose rates. Incidence of ovarian tumors also varied as a function of dose and dose rate in γ-irradiated mice but relatively few such tumors were induced by neutrons. The cumulative incidence of nonthymic lymphomas and lung tumors was increased by γ irradiation at low dose rates but was decreased at high dose rates, the decrease being greater and less dependent on intensity with neutrons than with x and γ rays. Other solid neoplasms were also observed but in insufficient numbers to define quantitative dose-effect relations. (auth)

19361 RADIATION INDUCED ANEMIA IN RATS EXPOSED REPEATEDLY TO MIXED GAMMA-NEUTRON RADIATION. Baum, S. J.; Varon, M. I.; Wyant, D. E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Radiat. Res.; 41: 492-9(Mar 1970).

Experiments were performed to test the hypothesis that rats could be made permanently anemic by repeated mixed γ-neutron irradiations and that once the maintenance of normal circulatory red cell concentration was lost, the administration of exogenous erythropoietin could not restore the production of red cells to normal levels. Rats were exposed to nine periodic doses of 150 Rads of mixed γ-neutron radiation or to four periodic doses of 300 Rads. Hematocrits and erythrocyte counts obtained for 100 days or more after the final radiation exposure showed a significant reduction in erythrocyte production. This permanent anemia was not ameliorated by the treatment with five daily doses of either 5 or 25 units of erythropoietin. These findings appear to strengthen the hypothesis that the permanent anemia is caused by a reduced capability for cellular proliferation due to accumulation of residual injury in stem cells. (auth)

19362 RADIOSENSITIVITY OF THE PROCESS INITIATING BONE MARROW REGENERATION. Patt, Harvey M.; Maloney, Mary A. (Univ. of California, San Francisco). Radiat. Res.; 41: 500-6(Mar 1970).

Studies were made of the radiosensitivity of the mechanism that initiates marrow restoration after localized depletion of the rabbit femur. The femur was x-irradiated, with the remainder of the body shielded, just prior to its depopulation by dextran perfusion. The status of marrow regenerating during the first 4 weeks was determined by the incorporation of tritium-labeled thymidine into DNA and by the number of hemic cells in the mechanically ablated femur relative to the contralateral limb. A radiation dose-response curve was derived that had a form similar to that for mammalian cell survival, with a threshold region of about 200 R and a D_0 of approximately 325 R. It is emphasized that the parameters of the dose-response relation for marrow regeneration cannot be equated necessarily with similar parameters derived specifically for cell survival. The present results provide further evidence for the local origin of the repopulating cells. However, whether the initiation of the various facets of marrow regeneration was due to uncommitted mesenchymal elements or to more than one cell type (for example, stromal stem cells and hematopoietic stem cells) in osseous tissue remains a moot point. (auth)

19363 SOME BIOLOGICAL EFFECTS OF LASER RADIATION. Ham, W. T. Jr.; Williams, R. C.; Geeraets, W. J.; Mueller, H. A.; Ruffin, R. S.; Schmidt, F. H.; Clarke, A. M. (Medical Coll. of Virginia, Richmond). pp 131-48 of Thermal Problems in Aerospace Medicine. Hardy, J. D. (ed.). Maidenhead, Eng., Technivision Services, 1968.

From Conference on Thermal Problems in Aerospace Medicine, Lisbon, Portugal and Fuerstenfeldbruck, Ger. See CONF-640935; CONF-650998; AGARDograph-111.

There was a fundamental difference in the physical phenomena and biological consequences accompanying exposure of the mammalian retina to high power density beams (megawatts/cm^2 from Q-switched lasers) as compared to moderate power density beams (kilowatts/cm^2 from normal laser pulses and pulsed xenon lamps). A radiation dose of approximately 0.07 J/cm^2 produced irreversible damage to the rabbit retina from a Q-switched ruby laser (exposure time 30 nsec), whereas it required approximately 0.85 J/cm^2 to produce irreversible damage from a laser pulse lasting for 200 μsec or longer. No definite physical or biological differences between ruby laser pulses and pulsed white light sources of comparable power density were detected for minimal damage to the rabbit retina. Both types of exposure can be explained adequately in terms of thermal injury using a simplified physical model and the classical law of heat conduction. Ophthalmoscopically visible damage to the rabbit retina for exposure times ranging from 200 μsec to 20 msec requires a remarkably uniform temperature in the pigment epithelium, which is estimated to be close to 100°C. For steady state exposure to a laser beam the maximum temperature and time taken to attain equilibrium depended primarily on the retinal image size. For an image whose diameter is 20 microns, equilibrium was attained in approximately 10 milliseconds. (auth)

19364 SOME EFFECTS OF ACUTE AND CHRONIC MICROWAVE IRRADIATION OF MICE. Hyde, A. S.; Friedman, J. J.

(Wright-Patterson AFB, Ohio. Indiana Univ., Bloomington). pp 163-75 of Thermal Problems in Aerospace Medicine. Hardy, J. D. (ed.). Maidenhead, Eng., Technivision Services, 1968.

From Conference on Thermal Problems in Aerospace Medicine, Lisbon, Portugal and Fuerstenfeldbruck, Ger. See CONF-640935; CONF-650998; AGARDograph-111.

Groups of 10 female mice were acutely irradiated with 3 cm microwaves for nine combinations of instantaneous powers of pulse repetition rates of 300, 600, and 100 cps and average powers of 0.017, 0.040, and 0.060 watts/cm^2. There were three categories of exposure; continuous for a total of 0.22 watt-minutes/cm^2; continuous until intraperitoneal temperature reached 40°C; and intermittent for a total of 0.22 watt-minutes/cm^2. Thus 27 groups composed a 3 × 3 × 3 matrix. The animals' thermal response related to the total energy delivered rather than to the average power, instantaneous power, or duration of exposure per se. At 3, 7, and 20 days after irradiation there was no significant response difference between the 27 groups of mice with respect to mean hemoglobin concentration, leukocyte concentration, and body weight. The experimental groups' total leukocyte count did, however, show an abnormal, extreme range of variation. Mean differential leukocyte counts did not vary significantly from control groups' nor did the femoral bone marro.. smears show a consistent shift. High and low dose nonthermal and thermal acute 3 cm microwave irradiation caused a highly variable response in post-irradiation weight; the most consistent response was that of mild weight loss one week after irradiation. Repeated acute thermogenic exposures to high dose 3 cm microwaves of 0.24 watt-minutes/cm^2 caused severe weight loss greater than 10%, in 18 days. The cumulative effects of chronic nonthermogenic exposure to low doses of 10 cm microwaves (0.02 watt-minutes/cm^2) were studied by nonthermogenically irradiating mice for three weeks. After 21 days of chronic irradiation, body weight increased 4 to 6% when compared to controls. The rationale of the present maximum safe exposure level (0.01 watt/cm^2) is briefly discussed. (auth)

19365 VISCERAL LESIONS OBSERVED IN MICE AND RATS EXPOSED TO ULTRA-SHORT WAVES. STUDY OF THE EFFECTS OF THESE WAVES ON REPRODUCTION OF THESE ANIMALS. Miro, L.; Loubiere, R.; Pfister, A. (Ecole Pratique des Hautes-Etudes, Paris). pp 177-83 of Thermal Problems in Aerospace Medicine. Hardy, J. D. (ed.). Maidenhead, Eng., Technivision Services, 1968. (In French).

From Conference on Thermal Problems in Aerospace Medicine, Lisbon, Portugal and Fuerstenfeldbruck, Ger. See CONF-640935; CONF-650998; AGARDograph-111.

Three series of six animals each were exposed to microwaves; the first for 190 hrs, the second for 300 hrs, and the third for 450 hrs. Following irradiation the animals were killed and tissue samples were fixed and sectioned for histological study. Special staining techniques were used for some tissues. Microscopic examination of the tissues revealed that there was no damage to the heart, lungs, kidneys, adrenals, or pancreas. The spleen was hypertrophied and congested and the intestine showed infiltration of small mononuclear cells in the villi. Lesions of the liver and gonads occurred as a result of irradiation. In another series of experiments male and female mice and rats were irradiated for determining effects of radiation on the number and growth of their offspring. It was concluded that irradiation did not produce any pathological modification of the physiology of reproduction. (H.L.W.)

Man

Refer also to abstracts 19285, 19286, 19288, 19312, 19325, 19326, 19340, and 19342.

19366 TREATMENT OF THYROTOXICOSIS WITH LOW DOSES OF RADIOACTIVE IODINE. Goolden, A. W. G.; Fraser, Russell (Hammersmith Hospital, London). Brit. Med. J.; 3: 442-3(23 Aug 1969).

The disadvantage of ^{131}I therapy for thyrotoxicosis of a rising incidence of hypothyroidism with the passage of time was discussed. In a series of 156 thyrotoxic patients treated with low doses of ^{131}I the therapeutic dose was calculated by means of a sliding scale in which the dose level was varied according to the estimated size of the gland. The incidence of hypothyroidism at 1 yr was 5%. Of the 88 patients who were euthyroid at 1 yr, 1 became hypothyroid at 2 yr and 1 at 4 yr. The incidence of hypothyroidism at 1 yr in a series of 564 patients treated between 1950 and 1962 was 17%. In a series of thyrotoxic patients that compared high- and low-dose levels, in the low-dosage group given a dose of 80 μCi ^{131}I/estimated gram of thyroid tissue, the incidence of hypothyroidism after a mean follow-up period of 19 months was 6%. The incidence of hypothyroidism was reduced to 4.3% in a group of patients given a radiation dose of 3500 rad. The cumulative incidence of hypothyroidism in these patients was 7.4% at 5 yr. It was suggested that an incidence of hypothyroidism of 5% at 1 yr was probably acceptable, and it seemed impracticable to attempt to reduce it any further. A certain incidence of hypothyroidism was expected with any method of treatment, and the incidence after surgery was probably higher than was generally realized. (BBB)

19367 PSEUDOARTHROSIS OF THE SCAPHOID BONE FOLLOWING RADIOTHERAPEUTICALLY CAUSED FATIGUE FRACTURE. Kolar, J.; Bek, V. (Karlova Univ., Prague). Monatsschr. Unfallheilk.; 70: 257-9(Jun 1967). (In German).

A seven month old female with a large hemangioma covering the radio-carpal region received 4000 r of x radiation. Seven months later, an additional dose of the same amount was applied. Subsequently, bone development in the hand and the lower arm was drastically retarded. At the age of seven years, the left arm was 9.5 cm shorter than the right one. At the age of 15, a fracture developed spontaneously in the scaphoid bone that ended as a pseudoarthrosis. (H.B.G.)

19368 CHANGES IN PAIN THRESHOLD OF ORAL MUCOSA IN LARYNGECTOMIZED PERSONS AFTER THE X-RAY THERAPY. Iroshnikova, E. S.; Tagaevskii, L. I.; Tagaevskaya, Yu. L. (Medical Stomatological Inst., Moscow). Stomatologiya; 48: 69-71(Apr 1969). (In Russian).

Changes in sensitivity of the oral mucosa after irradiation are reviewed and discussed preliminary to a report of clinical studies. The x-ray reaction is compared to a nutritional disturbance having a characteristic gradual increase to a maximal development, and subsequent fading to the initial state. Bone, teeth, and the soft tissue of the oral cavity differ in absorption and scattering of ionizing radiation. The presence of metal alloys of dental fillings increases the reaction to irradiation. For the soft tissue the highest degree of absorption of irradiation is in alveolar processes and the hard palate. The authors examined 76 healthy persons and 135 persons with defective teeth, and established that the fluctuation of pain sensitivity between morning and evening is insignificant, except in neuropsychiatric cases. An esthesiometer was used to determine oral mucosa pain threshold in alveolar processes and hard palate of 30 laryngectomized persons undergoing radiotherapy. After x ray therapy with total doses varying from 1200 to 12,800 R and laryngectomy the pain sensitivity threshold in healthy as well as in laryngectomized persons was higher in the maxilla than the mandible. After x irradiation the sensitivity of oral mucosa decreased by 10 to 20%, and a higher irradiation dose resulted in a proportionally lower pain sensitivity. (BBB)

19369 THERMAL PROBLEMS IN AEROSPACE MEDICINE. Meeting of the Aerospace Medical Panel of the Advisory Group for Aerospace Research and Development (NATO), Lisbon, Portugal, September 1964 and Fuerstenfeldbruck, Germany, September 1965. Hardy, J. D. (ed.). Maidenhead, Eng., Technivision Services, 1968. 260p. (In French and English). (AGARDograph-111; CONF-640935; CONF-650998).

Four separate abstracts were prepared for inclusion in NSA. These were in the section on effects of laser and microwave radiation. Other sections of the book are intense heat and thermal radiation and exposure of humans to hot and cold water. (C.O.)

For abstracts of individual sections see: 19363–19365 and 19370.

19370 CUTANEOUS RECEPTOR RESPONSE TO MICROWAVE IRRADIATION. Hendler, Edwin (Naval Air Development Center, Johnsville, Pa.). pp 149-61 of Thermal Problems in Aerospace Medicine. Hardy, J. D. (ed.). Maidenhead, Eng., Technivision Services, 1968.

From Conference on Thermal Problems in Aerospace Medicine, Lisbon, Portugal and Fuerstenfeldbruck, Ger. See CONF-640935; CONF-650998; AGARDograph-111.

Differences in conductive and volumetric tissue heating were investigated in an attempt to elucidate the mechanism of cutaneous warmth sensation to microwave irradiation. The forehead was selected as the area for study; subjects were university students and laboratory personnel of both sexes. It was found that both infrared and microwave stimuli that were capable of evoking threshold sensations produced a temperature increase of between 0.01 and 0.02°C of the layer lying 200 μ deep over that located 1000 μ below the surface. Analysis of the infrared data indicated that the threshold of warmth sensation could be correlated with a temperature rise of about 0.02°C, occurring about 200 μ below the surface of the skin. (C.O.)

19371 NEUROPATHOLOGY. Kaufman, M. A.; Roizin, Leon; Gold, George. Progr. Neurol. Psychiat, 23: 110-33(1968).

Nervous system disorders in man and several animal species are reviewed. The processes leading to neuropathological conditions are described, such as inflammation, aging, degeneration, toxicity, effects of irradiation, malformations and malfunction of circulation and metabolism. (F.M.M.)

19372 STATISTICAL SURVEY OF LEUKEMIA AMONG INDIVIDUALS IRRADIATED OCCUPATIONALLY AND THERAPEUTICALLY IN EAST JAPAN. Miyata, Hisatoshi (Japan Red Cross Central Hospital, Tokyo); Enomoto, Hidetoshi; Maeda, Kazuho. Nippon Ketsueki Gakkai Zasshi; 43: 784-91(Oct 1968). (In Japanese).

A statistical survey was made of leukemia occurring in individuals exposed to ionizing radiation. The investigation was carried out throughout Japan, for purpose of analysis divided into East and West Japan. The results of the survey in East Japan are reported. Eighty-nine instances of leukemia occurring during the past 20 years in individuals with a history of exposure to radiation in East Japan were collected. Of these 89 cases, 18 had been occupationally irradiated, including 5 physicians, 1 nurse, 8 technicians, and 4 scientists; 28 had received radiotherapy for a variety of diseases, including 18 neoplastic diseases (cancer of the uterus 9, cancer of the breast 7, 1 each of cancer of the pharynx and cancer of the skin, eczema 2, hemangioma 3, and 1 each of lymphangioma, tuberculosis of the lung, nasal polyp, Graves' disease, and thyrotoxicosis). All had been treated with x or γ rays, except the case of thyrotoxicosis that had received radioiodine therapy. Three cases followed Thorotrast injection and 8 were children exposed in utero to radiation during diagnostic abdominal or pelvic x-ray studies of the mother. There were 18 atomic bomb survivors of Hiroshima and Nagasaki and 13 others that had entered one of these cites soon after the bombing. Most cases of leukemia developing after irradiation were of the myeloid type, but comparison of the distribution of the types in the various exposure categories indicated that after occupational irradiation more cases of the chronic types developed, i.e., the acute-to-chronic ratio was 0.8; while after therapeutic irradiation there were more of the acute type, i.e., showing an acute-to-chronic ratio of 5.8. Atomic bomb exposure resulted mainly in cases of the chronic type, as in the occupational group, i.e., an acute-to-chronic ratio of 0.9. The incidence of leukemia developing after radiotherapy for cancer of the breast and of the uterus for the periods from 1950 to 1965 and from 1951 to 1965, respectively, was calculated, and the population at risk was estimated from the number of deaths from each cancer during the same periods. At present the observed incidence is not significantly higher than the expected incidence. (BBB)

Radiation Effects on Plants

Refer also to abstracts 19295, 19296, 19311, 19329, and 19330.

19373 EFFECTS OF 14 MeV NEUTRONS AND 300 kVp X-RAYS ON GEOTROPIC RESPONSE AND SEDIMENTATION VELOCITY OF STATOLITHS IN BARLEY ROOTS. Cercek, L. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 16: 419-29(1969).

The effects of 300 kVp x rays and 14-MeV neutrons on the geotropic response and the sedimentation of statoliths in the statocytes of barley roots were studied. Twenty-four hours after irradiation with 100 rads of x rays or 60 rads of 14-MeV neutrons in air, the geotropic response was inhibited by 25 and 15%, respectively. Higher doses up to 800 rads of x rays or 220 rads of neutrons had no greater effect. Irradiation in the absence of oxygen did not affect the geotropic response, and a slight enhancement was observed. Sedimentation of statoliths was slowed down after irradiation in air and speeded up after irradiation in the absence of oxygen. The hypothesis is put forward that the effects of radiation on geotropic response are due to the changes in the viscosity of the protoplasm; irradiation in air increases the viscosity; whereas irradiation in the absence of oxygen decreases it. Mechanisms for the effects of radiation on the viscosity of the protoplasm are suggested. (auth)(UK)

Radiation Effects on Microorganisms

Refer also to abstracts 19295 and 19296.

19374 (ORO-3630-7) PHOTOREPAIR OF UV DAMAGE TO DNA: STUDIES WITH THE DNA-PHOTOREACTIVATING ENZYME. Three Year Summary, April 1, 1967-January 2, 1970. Werbin, Harold (Texas Univ., Dallas). Contract AT(40-1)-3630. 24p. Dep. CFSTI.

The goals and research accomplishments over a three-year period in the investigation of the photorepair of DNA damage by uv irradiation are summarized. Early research in the investigation was concerned with the photoreactivation of RNA phages. It was found that f2 phage adsorbed to the cells of a strain of Escherichia coli that was relatively insensitive to far-uv radiation, but the RNA penetration was significantly reduced. As in the case of other RNA phages, the f2 phage could not be successfully photoreactivated because the small amount of RNA that did penetrate the host could not initiate replication. In searching for a photoreactivable virus, DNA phycovirus, LPP-1, that infects the blue-green alga Plectonema boryanum (a photoautotrophic organism) was discovered. Photoreactivation of the virus, and the uninfected host as well, led to the conclusion that this organism had a high content of DNA-photoreactivating enzyme. This was the case, but cell-free extracts from the alga were unstable and tended to degrade the substrate during assay. The same was true of extracts from pinto-bean sprouts and a second blue-green alga Anacystis nidulans. Once an abundant source of the enzyme is found, that will remain stable during purification procedures, purification can be accomplished and the chemical and physical parameters of the enzyme can be determined. Only then can the mechanism of action of the enzyme at the molecular level be studied. A brief summary of proposed research and a detailed statement of the present state of knowledge concerning photoreactivation in vitro and its significance in biology and medicine are also included. (E.R.B.)

19375 E. COLI CELLS WITH INTACT AND DEFECTIVE DARK REGENERATION MECHANISMS FOR STRUCTURAL INJURIES OF DNA USED AS A SCREENING MODEL IN THE SEARCH FOR POTENTIAL CARCINOSTATICS. Fleck, W. (Institut fuer Mikrobiologie and Experimentelle Therapie, Jena, Ger.). Z. Allg. Mikrobiol.; 9: 217-21(1969). (In German).

The ability of cells to recover from damage to cellular DNA produced by uv irradiation, x irradiation, and ^{32}P disintegration was discussed. A quantitative screening procedure that used Escherichia coli cells to evaluate recovery from DNA injury induced by irradiation was described. A method to measure the DNA injuries produced in the cells was presented and its application to uv-irradiated mutant cells was discussed. Effects on incorporation of ^{3}H-labeled precursors of DNA synthesis were described. The advantages of the test procedure outlined were compared to the prophage induction test procedure. Induction of DNA injuries by uv irradiation were discussed briefly. (BBB)

19376 EFFECT OF HEAVY WATER ON THREE HIGH PRODUCING STRAINS OF PENICILLIUM CHRYSOGENUM. Mohammed, Kasheed; Nona, Daniel A.; Blake, Martin I. (Univ. of Illinois, Chicago). J. Pharm. Sci.; 59: 419-21(Mar 1970).

Three high antibiotic-producing strains of Penicillium chrysogenum (Wisconsin Q176, 51-20F3, and 49-133) were examined for their ability to grow and produce penicillin nutrient solutions containing pure heavy water. Penicillin titer values and pH changes were observed over the culture study period. Wisconsin Q176 responded most favorably. Continuous feeding of dextrose and potassium phenylacetate gave better antibiotic titers than a single addition of the two components. With either feeding regimen, potassium phenylacetate was more effective as a precursor than N-(β-hydroxyethyl)phenylacetamide of α-phenylacetamide. L-Leucine added together with potassium phenylacetate further enhanced penicillin production. The production of the yellow pigment associated with Wisconsin Q176 in protio nutrient cultures was suppressed in deuterium oxide nutrient cultures. (auth)

19377 THE UV SENSITIVITY OF SOME EARLY-FUNCTION TEMPERATURE-SENSITIVE MUTANTS OF PHAGE T4. Baldy, Marian W. (Univ. of California, Davis). Virology; 40: 272-87 (Feb 1970).

Temperature-sensitive (ts) mutants of phage T4 defective in ten early function genes were tested for sensitivity to ultraviolet (uv) light. The mutants were irradiated, plated on Escherichia coli S/6, and incubated at temperatures from 18 to 45°. Ultraviolet-radiosensitivity was shown by ts mutants defective in genes 30 (polynucleotide ligase), 32 (joint former), 41 (function unknown), 42 (deoxycytidylate hydroxymethylase), 43 (DNA polymerase), 44 (function unknown), 46, and 47 (deoxyribonucleases). Ts mutations in genes 45 (function unknown) and 56 (dCTP-dUTP nucleotidohydrolase) did not lead to uv sensitivity. The uv sensitivity of mutants defective in genes 30, 43, 46, and 47 is consistent with the model of DNA repair by excision. The observation that eight of ten early function genes contain uv-sensitive mutants is thought to reflect the complexity of the process of uv repair in T4-infected cells. (auth)

Radiosterilization and Radiopreservation

Refer also to abstracts 19025, 19137, 19174, and 19175.

19378 (COO-2038-1) STUDY OF CONTROL OF PUBLIC HEALTH PROBLEMS USING IRRADIATION. Technical Progress Report. (Nebraska Univ., Lincoln). [nd]. Contract AT(11-1)-2038. 6p. Dep. CFSTI.

A survey was made of commercial red meat products (ground beef and pork sausage) at the level of the retail outlet to determine the magnitude of general microbial contamination and the frequency of occurrence of indicator microorganisms (coliforms) of public health significance. The general microbial count and the number of coliforms present in the fresh samples were high, and following a six-day period of storage in a household refrigerator these counts reached an unacceptable level in all of the samples. The results, which are presented in tabular form, indicate that the ground beef especially constituted a public health hazard under present retail conditions. Irradiation of ground beef samples at dose levels of 37 and 74 kRad significantly reduced both the general microbial count and the number of coliforms present. No objectionable flavor changes occurred in the irradiated samples even at the higher dose level. (E.R.B.)

19379 MILK IN RADIOACTIVE IRRADIATION. Holden, Wilhem (Univ., Graz). LE (Lebensm. Ernaehr.); 19: 4-8(Sep 1966). (In German).

The significance of radioisotopes and ionizing radiations as applied in dairy science and technology of milk and milk products was reviewed briefly. The use of irradiation to destroy various types of staphylococci or salmonellae in milk, and to sterilize equipment surfaces by irradiation was discussed. Rubber surfaces were most subject to bacterial contamination, glass surfaces were much less susceptible, but plastic was least likely to be contaminated and was easiest to sterilize with irradiation. The study of milk protein constituents with radioisotopes and the removal of ^{89}Sr, ^{90}Sr, and ^{137}Cs from milk were also discussed. Stepwise procedures for removal of radioisotopic contaminants from milk were itemized. Methods for estimation of contamination with ^{90}Sr, ^{137}Cs, ^{140}Ba, and ^{131}I were discussed. Effects of coagulation methods on ^{90}Sr and ^{131}I decontamination of cheese, skim milk, cream, butter, and buttermilk were outlined. The possibilities of using milk after contamination with radioactive fallout were discussed. Contamination of milk with ^{137}Cs was increased when fodder with high concentrations of ^{137}Cs fallout was fed to dairy cows. Estimation of trace elements in milk and milk products by means of neutron activation analysis was discussed. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 19169.

19380 (JPRS-49787) DISPERSION TYPE FUEL ELEMENTS FOR NUCLEAR REACTORS. Samoilov, A. G.; Kashtanov, A. I.; Volkov, V. S. Translated from pp 103-262 of Dispersionnye Teplovydelyayushchie Elementy Yadernykh Reaktorov, Atomizdat, Moscow, 1969. 147p. CFSTI.

Selected results of research on materials for construction of reactors and reactor components are summarized. Data and comment are included based on test results from in-pile and out-of-pile programs devoted to Al and its alloys, Zr and its alloys, alloys based on iron, Ni and its alloys, refractory metals, and graphite. 261 references. (J.R.D.)

19381 (ORNL-4512) HEAVY-SECTION STEEL TECHNOLOGY PROGRAM. Semiannual Progress Report for Period Ending August 31, 1969. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 122p. Dep. CFSTI.

Results of research and development on pressure vessel steel are reported in four sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 19396, 19419, 19420, and 19471.

Corrosion and Erosion

Refer also to abstract 20552.

19382 (CEA-N-1130) RELATIONS BETWEEN THE KINETICS OF OXIDATION OF α ZIRCONIUM AND THE DIFFUSION PHENOMENA OF OXYGEN THROUGH THE OXIDE FILM AND IN THE UNDERLYING METAL. Beranger, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1970. 164p. (In French). Dep. CFSTI (U.S. Sales Only).

Thesis. Submitted to Paris Univ., France.

The oxidation of α zirconium in oxygen at 550 to 850°C at atmospheric pressure for exposure times of less than 100 hr was investigated. After a deviation in the initial stage, the reaction kinetics follow a parabolic law. The growth of superficial oxide film and the dissolution of oxygen in metal are the simultaneous and elementary processes characterizing zirconium oxidation. The kinetics of these reactions also follow a parabolic law. A deviation from this law is only observed for the growth of the oxide at the beginning of the reaction. A nondestructive method for the analysis of oxygen, based on the application of the nuclear reaction $^{16}O(d,p)^{17}O$ was developed for the quantitative determination of the diffusion profile of oxygen dissolved in zirconium. The temperature dependence of the oxygen diffusion coefficient in zirconium, determined by means of microhardness measurements, reveals a rapid diffusion at $t < 650$°C. The phenomenon could be interpreted by a grain-boundary process at low temperature. Observations made during electrotransport and electrolysis experiments were compared with those made during zirconium oxidation experiments. They are both in favor of the existence of an anionic diffusion process. Moreover, the ESR study shows that only about 1% of the defects of substoichiometric zirconia are paramagnetic. Morphological and structural observations were carried out in order to study the nucleation and the growth of oxide at different pressures and temperatures. These different results are interpreted in terms of an anionic diffusion process through the oxide and oxygen diffusion in the underlying metal. (auth) (France)

19383 (EURFNR-696) THE WEAR BEHAVIOR OF STEELS AND ALLOYS IN LIQUID SODIUM. Wild, E.; Mack, K.; Hoffmann, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorbauelemente). Translation of report KFK-973. 51p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

The wear behavior of pairs of materials for bearings and bushings for sodium-cooled reactors was examined for 36 different combinations of materials under the same operating conditions. The model geometry used consisted of three cylindrical samples which performed oscillating movements on a disk. The investigations were carried out in a test rig with a continuous sodium flow. The more favorable combinations of materials are to be tested in more detailed parameter studies, with special attention to the influence of temperature, stress, sliding velocity, and the oxide content of the sodium. (auth)

19384 OKISLENIE I ZASHCHITA BERILLIYA. (Oxidation and Protection of Beryllium). Papirov, I. I. Moscow; Izdatel'stvo Metallurgiya (1968). 121p.

The influence of various factors on beryllium oxidation and protection in various gaseous media (O_2, N_2, CO_2, CO, etc.) was analyzed in a wide range of temperatures and pressures. Data are given on kinetic, optic, electron microscopic, x-ray, and electronographic studies. Mechanisms of beryllium oxidation in dry gases and humid environments and beryllium reaction with water vapor and humid gases are discussed. Oxidation of beryllium alloys and berylliides are also discussed. Radiation effects on beryllium oxidation and beryllium coating protection are briefly reviewed. (102 references) (R.V.J.)

19385 ROLE OF NITROGEN IN THE FORMATION OF MICROBUBBLES DURING THE EXPLOSIVE COMBUSTION OF ZIRCONIUM DROPLETS IN N_2/O_2 MIXTURES. Meyer, R. T.; Nelson, L. S. (Sandia Labs., Albuquerque, N. Mex.). High Temp. Sci.; 2: 35-57(Mar 1970).

Previous studies have indicated that internally released gaseous N_2 may drive the explosions of falling zirconium droplets as they burn at high temperatures (3000 to 4300°K) in N_2/O_2 mixtures at 625 torr. The formation of microbubbles under threshold conditions for explosion has been investigated by mass spectrometric, spectroscopic, pyrometric, photographic, gravimetric, and chemical techniques. The results indicate (i) that N_2, and only N_2, is present within the microbubbles at room temperature, but always at a pressure too low to have inflated them, and (ii) that ZrO(g) is an important vapor species at the temperature of combustion. On the basis of a large aggregation of experimental and theoretical evidence, it is proposed here that the partial pressures of N_2(g) and ZrO(g) above a decomposing ternary liquid alloy of zirconium oxygen, and nitrogen combine to drive the explosions. It is further suggested that gaseous N atom recombination may provide a localized source of energy for bubble nucleation in the melt. (auth)

19386 COMPARISON OF CHEMICALLY AND ELECTROLYTICALLY INDUCED PITTING CORROSION. France, W. D. Jr. (General Motors Corp., Warren, Mich.); Greene, N. D. Corrosion; 26: 1-4(Jan 1970).

Pitting of zirconium and stainless steel in acidic and near-neutral chloride media has been investigated. It is shown that controlled potential and conventional chemical corrosion tests do not yield similar rates or types of attack under identical environmental conditions. Such discrepancies limit critical pitting potential measurements and related techniques for evaluating and comparing pitting in halide environments. A theoretical explanation based on the accumulation of chloride at anodically polarized electrode surfaces is presented. (auth)

19387 PREDICTIONS OF CORROSION RATES OF STAINLESS STEEL IN FLOWING LIQUID SODIUM. Blair, R. C.; Munir, Z. A. (San Jose State Coll., Calif.). Corrosion; 26: 15-18(Jan 1970).

Based on a thermodynamic partitioning of oxygen, a mechanism for the corrosion of stainless steel in flowing liquid sodium is suggested. The model includes consideration of the equilibrium between sodium, iron, and their dissolved oxides. A reasonable agreement is obtained when corrosion rate values predicted by this mechanism are compared with those obtained experimentally using nearly 200 stainless steel specimens and employing four test systems operated under six different conditions. (auth)

19388 THERMOCHEMISTRY AND THE OXIDATION OF REFRACTORY METALS AT HIGH TEMPERATURE. Gulbransen, Earl A. (Westinghouse Research Labs., Pittsburgh). Corrosion; 26: 19-28(Jan 1970).

Recent developments in the thermochemical data for the condensed oxide phases and volatile oxide species for the refractory metals have made possible an analysis of the several types of high temperature oxidation processes. Results of the analyses show that the presence or absence of oxide films or scales on the metals, the melting points of the one or more oxide phases, the equilibrium pressures of the several volatile oxides, and the flow rate of reactant gases are important factors. The thermochemical predictions are compared with experimental observations for molybdenum and tungsten. (auth)

19389 CORRELATION BETWEEN CONSERVATION OF METAL AND LUMINOSITY OF A ZIRCONIUM DROPLET DURING FREE-FALL COMBUSTION IN OXYGEN. Nelson, L. S.; Levine,

H. S. (Sandia Labs., Albuquerque, N. Mex.). High Temp. Sci.: 1: 163-8(Jul 1969).

The retention of metal during the free-fall combustion of single droplets of laser-ignited zirconium has been studied by comparing the luminous history of each droplet with its ultimate weight and composition. A correlation is observed between the ultimate weight change of each droplet and the duration of a hump on its luminosity-time record. The paradoxical conservation of zirconium at burning temperatures near its boiling point is tentatively explained by a reflux action resulting from the formation of a fog layer of condensing oxide droplets around the parent droplet. As the pressure of oxygen is reduced, condensation occurs less readily and the loss of zirconium occurs as expected. (auth)

19390 THE CORROSION OF Ta BY Na_2O-SATURATED LIQUID Na. Alcock, C. B.; Barker, M. G.; Stavropoulos, G. P. (Imperial Coll. of Science and Tech., London). Corros. Sci.: 10: 105-10(Feb 1970).

The product of the corrosion of Ta by O_2-saturated liquid Na in the temperature range 300 to 550°C was found to be Na_3TaO_4. The kinetics of the attack are complex, being parabolic in the lower half of the temperature range, but linear for a limited period at the higher temperatures. After about 90 min the corrosion rate, at the higher temperatures, decreases markedly, indicating that the tantalate coating is relatively protective. (auth) (UK)

19391 APPLICATION OF SCHAEFER'S RULES TO THE HIGH TEMPERATURE TUNGSTEN TRANSPORT REACTIONS. Campbell, R. J. (General Electric Co., Cleveland). High Temp. Sci.: 1: 303-12(Oct 1969).

The transport phenomena produced by the high temperature tungsten oxidation equilibria were studied. It was shown that the thermodynamic principles of transport chemistry outlined by Schäfer are extremely useful in interpreting the transport behavior. A simple direct experimental approach demonstrated that the direction of tungsten transport along a temperature gradient as well as the specific transport species could be correctly predicted with the aid of Schäfer's Rules. (auth)

19392 CORROSION OF Nb-1 PERCENT ZIRCONIUM OR TANTALUM HEAT PIPE MATERIALS IN LIQUID LITHIUM. Busse, C. A. (EURATOM-CCR, Ispra, Italy). Corros. Sci.: 10: 65-84(Feb 1970). (In German).

Nb-1% Zr or Ta heat pipes operated at temperatures of 1500 or 1600°C with Li as working fluid can be corroded with wall perforation in the heating zone within a few hours. The analysis of such heat pipes, as well as considerations of fluid dynamics and thermodynamics, leads to the conclusion that the corrosion is caused by the initial oxygen content of the wall material. The corrosion mechanism consists in the transition of oxygen from the wall material of the cooling zone to the liquid Li, transport of the oxygen to the heating zone, local increase of the oxygen concentration in the liquid Li by the evaporation process, and finally wall attack by this oxygen rich Li. The corrosion can be reduced or completely inhibited by deoxidation of the wall material by the addition of Ca to the Li or of Y to the Ta. (auth) (UK)

19393 EFFECT OF TUNGSTEN-FLUORINE BONDS ON TUNGSTEN OXIDATION. Siegel, Bernard; Johnson, Richard L. (Aerospace Corp., El Segundo, Calif.). High Temp. Sci.: 1: 253-7(Jul 1969).

Data on the retardation of oxidation of tungsten metal by conversion of the metal to a fluoride of very low fluorine content are given. A fluoride with an empirical composition of $WF_{0.31}$ was prepared by electrically exploding the metal into an atmosphere of PF_5. Oxidations were carried out by heating 70 to 100 mg of $WF_{0.31}$ and tungsten powders at 500°C. After one hour pure tungsten powder was completely oxidized but only about 10% $WF_{0.31}$ was oxidized, followed by a substantial period in which oxidation practically ceased. The synthesized $WF_{0.31}$ was found to be nonhomogeneous, containing at least two overall formulas; about 10% of a monofluoride which was rapidly oxidized at 500°C as was the pure tungsten powder, and $WF_{0.24}$ which was strongly resistant to oxidation. (G.M.C.)

Preparation and Fabrication

Refer also to abstracts 19129, 19138, 19164, 19181, and 19485.

19394 (ANL-7647) THE MANUFACTURE OF VIBRATORILY COMPACTED FUEL ELEMENTS FOR DOPPLER-COEFFICIENT MEASUREMENTS. Ayer, J. E.; Konicek, C. F.; Soppet, F. E.; Petkus, E. J. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 14p. Dep. CFSTI.

The procedures that are used to manufacture and assemble vibratorily compacted oxide fuels containing plutonium, depleted uranium, and uranium-233 materials are described. Thirty-two acceptable, low-density, fuel rods were made with loadings of 100% PuO_2, 100% $^{233}UO_2$, and various blends of $^{235}UO_2$-PuO_2. The granules for loading were prepared by tableting the respective oxide powder, granulating, firing, and sieving for the proper size range. Over 21 kg of dense, sintered granules were then loaded into the elements by vibratory compaction to densities ranging from 50.8 to 57.8% of theoretical. Fourteen elements were ½ in. in diameter and 18 were 1 in. in diameter; the jackets of six elements were made of Invar and the remaining 26 were Inconel. During in-pile testing, the elements are to be heated by resistance wire that is wrapped around the element. The longitudinal expansion of the elements during heating is accommodated by either a sliding seal or by spring loading on the exterior of the element. Eight of the elements have a sliding seal, whereas the remaining 24 are spring loaded. (auth)

19395 (IS-T-346) THE PREPARATION OF HIGH PURITY DYSPROSIUM, HOLMIUM AND ERBIUM BY THE LITHIUM REDUCTION OF THEIR TRICHLORIDE SALTS. Croat, John Joseph (Ames Lab., Iowa). Nov 1969. Contract W-7405-eng-82. 114p. Dep. CFSTI.

Thesis.

An investigation has been carried out to evaluate the preparation of Dy, Ho, and Er by the reduction of the anhydrous trichloride with Li vapor. Reductions of the anhydrous chloride with Li proved to be a possible alternative to the Ca-RF_3 process now used to prepare Dy, Ho, and Er at the Ames Laboratory. These liquid-vapor reductions were carried out at 900°C and resulted in 96% yields of metal containing low to moderate amounts of gaseous impurities. In addition the method proved effective in eliminating F without adding characteristic impurities such as Cl and Li. The overall purity of the as-reduced metal prepared from singly distilled chlorides averaged 99.94 wt % or 99.20 at. % while as-reduced metal prepared from doubly distilled chlorides averaged 99.97 wt % or 99.70 at. %. The purity of the sublimed metal prepared from both singly and doubly distilled chlorides averaged 99.98 wt % or 99.90 at. %. Overall yields of oxide to purified recovered metal was on the order of 70%. A comparison of the purity of metal prepared from the fluoride and the chloride process found that with the exception of 25 to 75 ppM by weight of F, the sublimed metal from both methods were essentially identical. However, the as-reduced metal from the fluoride process is of considerably lower purity than its counterpart reduced from the chloride due to the large amounts of Ta introduced during the high temperature reduction of the rare earth fluoride. Melting points, lattice parameters, and resistivity ratios were determined on both the as-reduced and sublimed Dy, Ho, and Er. These results were compared with sublimed metal prepared from the rare earth fluoride. (auth)

19396 (ORNL-4512, pp 1-6) PROGRAM ADMINISTRATION AND PROCUREMENT. (Oak Ridge National Lab., Tenn.).

Activities in a program to develop methods of predicting failure in large water reactor pressure vessels are reported. Information is summarized on fabrication and heat treatment of Type A533 heavy-section steel plates. (J.R.D.)

19397 (ORNL-tr-2285) METHOD FOR THE PREPARATION OF ALLOYS OF THE PLATINUM METALS. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Dutch Patent 6,809,169. 5p. Dep. CFSTI.

Dispersion strengthened alloys prepared by combining one or more metals of the Pt group with small additions of Ti, V, Y, Zr, Hf and/or Ta, and rare earths are described. Preparation methods are outlined and increased strength properties are reported. (J.R.D.)

19398 (WARD-3791-45) VANADIUM ALLOY CLADDING DEVELOPMENT. Quarterly Progress Report for the Period Ending December 31, 1969. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Feb 1970. Contract AT(30-1)-3791. 24p. Dep. CFSTI.

Small double arc melted ingots were prepared for use in research on interstitial effects in vanadium. Detailed plans for this program, using an ultrahigh vacuum system in conjunction with a microbalance, were made. A kinetic analysis was made of the reactions between vanadium and oxygen and nitrogen. Poor fabricability is reported for Vanstar alloys being processed. As a result, tubular material for the sodium corrosion task was produced (at WANL) by swaging material extruded at Argonne National Laboratory. Sodium corrosion loop reconstruction is near completion. Lower interstitial absorption was observed in vanadium alloys exposed to sodium at 690°C (in VTL-2) than previously reported for samples exposed at higher temperatures. In the

vanadium alloy-fuel compatibility study, no reactions were observed in fuel samples examined. However, some incompatibility (reaction) was seen in the vanadium alloy samples in contact with stoichiometric UC and hyperstoichiometric (U,Pu)C. The samples in contact with chromium stabilized (U,Pu)C fuel exhibited little if any reaction. Microhardness evaluation will be conducted in an attempt to substantiate these findings. The vanadium alloy samples inserted in EBR-II, in the WARD/BNW High Flux Program have reached approximately half their goal exposure. (auth)

19399 TECHNICAL NOTE ON FABRICATING ISOTROPIC BERYLLIUM. Moberly, John W.; Brown, Henry M. (Stanford Research Inst., Menlo Park, Calif.). Int. J. Powder Met.; 6: 61-2(Jan 1970).

An economical method of producing isotropic Be powder from commercially produced Be is described. The powder is initially pressed at 20,000 to 25,000 psi. The compressed powder is crushed to a coarser size powder agglomerate than the original size particles. The agglomerates are then repressed yielding a green billet nearly free of preferred orientation. The billet is pressurally sintered. (J.R.D.)

19400 A SECTIONING TECHNIQUE FOR COPPER, SILVER, AND GOLD AND ITS APPLICATION TO PENETRATION AND DIFFUSION STUDIES. Andersen, T.; Soerensen, G. (Univ. of Aarhus, Denmark). Radiat. Eff.; 2: 111-17(Jan 1970).

This technique, which is based on the formation of a corrosion film, is capable of removing from a metal surface layers ranging from less than 1 $\mu g/cm^2$ of metal to more than 100 $\mu g/cm^2$. Being insensitive to radiation damage of the metal surface, this corrosion film technique can be applied in studies of recoils from nuclear reactions as well as in studies of penetration and diffusion in solids. An electromagnetic isotope separator has been used to implant radioactive impurity atoms in copper, silver, and gold, and examples are shown where the corrosion film technique has been applied for the study of range distributions and diffusion processes. (auth)

19401 STUDY OF VOLATILIZATION AND CHEMICAL REACTIONS IN THE PLASMA TORCH. APPLICATION TO MIXTURES OF REFRACTORY OXIDES AND CARBON. Triche, H.; Butti, C.; Besombes-Vailhe, J. (Faculte des Sciences, Toulouse). Method. Phys. Anal.; 4: 379-87(Dec 1968). (In French).

Results of a study of refractory carbides synthesis (TiC, VC, TaC, SiC) in the plasma torch from oxides and carbon mixtures are reported. Volatilization curves were plotted with respect to time permitting analysis of reduction and carbide formation reactions. The results have been affirmed by crystallography study of the chemicals formed. The aspect of the volatilization curves is interpreted by considering the physicochemical state of the bodies formed and by taking into account the reaction enthalpy change. (auth)

19402 METHOD OF ELECTROPLATING. Chauvin, Guy; Facquet, Louis; De Vaulchier du Deschaux, Louis (to Commissariat a l'Energie Atomique). British Patent 1,184,393. 18 Mar 1970. Priority date 31 Jan 1967, France.

A method for electrodepositing metal layers on shapes composed of U, Pu, U alloy, or Pu alloys is described. A first layer of metal is electrodeposited on the shape followed by a second layer of either Zn, Pb, or In. The second layer is rendered impervious to outside agents and is more than 55 microns thick. (J.R.D.)

19403 IMPROVEMENTS IN CASTING PROCESSES. Manet, Michel; Ach, Jean-Noel. (to Commissariat a l'Energie Atomique). British Patent 1,183,635. 11 Mar 1970. Priority date 7 May 1966, France.

A process is given for casting metallic pieces such as uranium alloys for the least amount of defects in the finished pieces. The defects are cavities and porosities that appear when the temperature of the mold is insufficiently high. In the given process, the mold and the casting metal are first brought to a temperature higher than the solidification point of the casting metal, and then cooled by bringing into contact with the mold a cooling material which is initially at a temperature below the solidification point of the casting metal. (J.C.W.)

19404 A NEW METHOD FOR MANUFACTURING METAL-CLAD PLATES OF COMPACTED METALLIC AND CERAMIC POWDERS. Buehler, H.; Fickel, H.-P.; Mueller-Axt, F. (Technische Univ., Hanover). Kerntechnik; 12: 20-3(Jan 1970). (In German and English).

Clad compacted powders are frequently required in nuclear reactor engineering. The process of fabrication of such components includes steps pertaining to materials forming techniques and to powder metallurgy. In view of the extensive similarity of the equipment required, it seems desirable to combine and to overlap such individual steps. A new method for manufacturing metal-clad plates of compacted metallic and ceramic powders is described. This method combines processes of metal-forming and of powder compaction into a single fabrication step, and should be suitable for the manufacture of, for example, control and moderator rods of the types intended for the power reactors being planned. (auth)

19405 STUDY OF THE REDUCTION OF UO_2 BY MAGNESIUM OR CALCIUM DISSOLVED IN MOLTEN CHLORIDES. Sharma, Ram A.; Johnson, Irving (Argonne National Lab., Ill.). Met. Trans.; 1: 291-7(Jan 1970).

The reduction of solid UO_2 to uranium by magnesium or calcium dissolved in their molten chlorides was studied. The rate of reduction per unit area of UO_2 surface, at constant temperature and concentration of reductant in the molten chloride, was found to increase with time to a constant value. The rate of reduction per unit area was observed to be proportional to the concentration of reductant in the molten salt. The small increase observed in the reaction rate over the temperature range 750 to 850°C, suggests that the reduction is controlled by transport of the reductant to the reaction site. Solidified salt, containing UO_2 pellets which had been partially reduced, was sectioned, polished, and examined microscopically. The products of the reduction reaction formed concentric layers around the UO_2 pellets. Layers of metallic uranium and oxide containing small amounts of dispersed salt alternated with layers of salt containing small amounts of metallic uranium and oxide. The layers ruptured, presumably because the volume of the products, uranium and oxide, is greater than the volume of the UO_2. Therefore, an impervious layer did not form on the oxide surface to inhibit the reduction reaction. (auth)

19406 METHODS FOR REDUCING GRAIN GROWTH IN ZIRCONIUM ALLOYS WELDINGS. Brossa, F.; Musso, G.; Volta, G. (CCR-EURATOM, Ispra, Italy). Met. Ital.; 61: 585-92(Dec 1969). (In Italian).

Grain growth and variation of properties on the heat affected zones of Zircaloy 2 and zirconium 2.5% niobium alloys welded by different methods are discussed. The various known techniques to homogenize the material are reviewed. A new technique based on Cu-base nucleating agents is suggested. Examples of circumferential welds on Zr-2 and Zr-2.5% Nb obtained by this technique together with their structural, mechanical and thermal stability properties are presented. (auth)

19407 LAWS OF CRYSTALLIZATION OF METALLIC SYSTEMS. Borisov, V. T.; Dukhin, A. I.; Matveev, Yu. E.; Nikonova, V. V.; Rakhmanova, E. P. Sb. Tr. Inst. Metalloved. Fiz. Metal. Tsent. Nauch.-Issled. Inst. Chern. Met.; No. 59, 75-85(1968). (In Russian).

The theory of the normal mechanism of growth of crystals is discussed. A linear relationship was obtained for the dependence of the growth rate of Ga on the supercooling property at the crystallization front and the normal growth mechanism. Results are described from a study of the crystallization of In and CCl_4. Experimental results were used to construct a kinetic diagram for the phenyl salicylate-azobenzene and In-Bi systems. Results are given for measurements of supercooling at the crystallization front of the eutectic alloys Sn-Zn and Sn-Bi, and also of the nonequilibrium phase composition of the hypoeutectic alloys. (Referativnyi Zh.)

19408 PREPARATION OF VERY LARGE BISMUTH SINGLE CRYSTALS FOR NEUTRON FILTERS. Bednarski, S. (Inst. for Nuclear Research, Swierk, Poland). J. Cryst. Growth; 6: 193-4(Jan-Feb 1970).

The preparation of large single crystals of Bi having the desired shapes is described. The cylindrical single crystals had a diameter of 175 mm and weighed about 50 kg. The average mosaic misorientation spread was about 10 min of arc. The crystals showed a good transmission for thermal neutrons. (auth)

Properties Evaluations

Refer also to abstracts 19192, 19278, 19457, 19504, 19979, 19980, 19985, 19994, 20542, and 20555.

19409 (ANL-7644) METHOD FOR RECONSTRUCTING A THERMAL-EXPANSION GRAPH FROM TWO VALUES OF THE MEAN EXPANSION COEFFICIENT. Yaggee, Frank L.; Foote, Frank G. (Argonne National Lab., Ill.). Dec 1969. Contract W-31-109-eng-38. 13p. Dep. CFSTI.

A simplified method is presented for reconstructing a linear thermal-expansion graph from two known values of the mean expansion coefficient ($\bar{\alpha}$). This method assumes that the expansion

curve is a monotonic function of parabolic form, and is adequately defined by a quadratic polynomial. The method provides a means of calculating values of the instantaneous expansion coefficient (α) over any range of temperature between 0 and 1000°C, and of determining the polynomial coefficients A and B, which can be used to reconstruct the entire expansion curve. The simple computations can be done either graphically or on a desk calculator, and the results compare well within 1% of the values obtained by performing the dilatation experiment. The validity of this method is demonstrated for metals, alloys, ceramics, and cermets that have body-centered-cubic, face-centered-cubic, close-packed-hexagonal, and monoclinic crystal structures, and mean expansion coefficients with a fivefold difference in magnitude (5×10^{-6} to 23×10^{-6} units/unit-°C) for the temperature range from 0 to 1000°C. (auth)

19410 (CONF-691002) NINTH CONFERENCE ON THERMAL CONDUCTIVITY, IOWA STATE UNIVERSITY, AMES, IOWA, OCTOBER 6–8, 1969. Shanks, Howard R. (ed.) (Ames Lab., Iowa. Office of Naval Research, Washington, D. C. Iowa State Univ. of Science and Technology, Ames). Mar 1970. 744p. Dep. CFSTI.

This volume contains the texts of 52 papers and 27 abstracts of papers presented orally at the conference. A separate abstract was prepared for each of eleven papers. Papers for which no abstracts were prepared are concerned with thermal conductivities of materials at low temperatures, thermal conductivities of gases, thermal conductivities of liquids, and experimental methods. (J.R.D.)

For abstracts of individual papers see: 19411–19416, 19455, 19491–19493, and 19521.

19411 (CONF-691002–, pp 234–8) THERMAL CONDUCTIVITY OF SOME CUBIC SODIUM TUNGSTEN BRONZES. Martin, J. J. (Oklahoma State Univ., Stillwater); Shanks, H. R. (Iowa State Univ. of Science and Technology, Ames).

The sodium tungsten bronzes are the nonstoichiometric compounds with the general formula, Na_xWO_3. The thermal conductivity of a series of cubic sodium tungsten bronze crystals with $0.51 \leq x \leq 0.89$ have been measured at low temperatures. The temperature dependence of the thermal conductivity is similar to that of an impure metal. This result is consistent with the low resistivity ratios, 2 to 5, of these materials. The total thermal conductivity increases with the sodium concentration. Apparent Lorentz ratios of 3.5 and 2.5×10^{-8} V^2/K^2 at 200°K for samples with $x = 0.51$ and $x = 0.89$ respectively were found. If it is assumed that the electronic thermal conductivity is given by $L_0 \sigma T$, the Wiedemann–Franz–Lorentz rule, the lattice conductivity is found to be a significant contribution to the total for the lower x-value bronzes. The lattice contribution shows a maximum as a function of x for an $x = 0.78$ sample. This result is attributed to the ordering of the sodium atoms that occurs near $x = 0.75$. (auth)

19412 (CONF-691002–, pp 300–6) TUNGSTEN THERMAL CONDUCTIVITY AS MEASURED BY MODIFIED METHOD OF EXPONENTIAL TEMPERATURE DISTRIBUTION. Chechovskoi, V. Ya.; Vertogradskii, V. A. (Akademiya Nauk SSSR, Moscow. Institut Vysokikh Temperatur).

Measurements have been performed on wire specimens heated by passing electrical current in vacuum. Use has been made of exponential temperature distribution gradually displaced along the specimen due to the rider temperature variation. The exponent has been determined from the comparison of the resistivity change of two specimen sections without using the temperature coefficient of electrical resistivity. Resistance bridge has also been used. Tungsten thermal conductivity has been determined for the temperature interval of 1300 to 2500°K on the specimens of 99.9% purity with 0.1% addition of Mo. The calculated maximum random error of a single measurement does not exceed 6 per cent. (auth)

19413 (CONF-691002–, pp 307–17) THE LATTICE THERMAL CONDUCTIVITY OF NICKEL AND DILUTE NICKEL–RHENIUM ALLOYS ABOVE 400°K. Chari, M. S. R. (National Physical Lab., New Delhi (India)).

The thermal conductivity data of Kirichenko and Mikryukov on high-purity nickel and on dilute nickel–rhenium alloys are analyzed and discussed. The deduced values of the electronic and lattice components are found to have a variation with the temperature and with the addition of the solute metal, compatible with the standard theory. The method of Linde–Backlund is also found to be applicable to these data on high-purity nickel, apparently because the slope of the ρ-T curve (ρ being the electrical resistivity at the temperature T) above the Curie-temperature is large enough to give a correspondingly large $\bar{\rho}_0$ (on the negative side of the resistivity axis) which when added to ρ, can compensate for the use of the normal Sommerfeld value of the Lorentz number in lieu of the more appropriate temperature dependent value given by Makinson. This appears to be the reason why, in cases where $d\rho/dT$ is less steep above the Curie temperature (as in the case of the other "pure" nickel specimens used by Schofield, Powell et al., and Hogan and Sawyer) the Backlund method does not lead to understandable results. (auth)

19414 (CONF-691002–, pp 318–25) EXPERIMENTAL STUDY OF THERMAL AND ELECTRICAL CONDUCTIVITIES OF SINGLE CRYSTALS OF TUNGSTEN AT HIGH TEMPERATURES. Peletskij, V. E.; Sobol, Yan G.; Drujinin, V. P.

Results are presented on studies of single crystal tungsten having purity 99.98%. The thermal conductivity coefficient was measured using longitudinal thermal flow in cylinder-shaped specimens heated at one end by electron bombardment. The measurements have been carried out within the 1200 to 2500°K range. The uncertainty in the measurement of the thermal conductivity coefficient is assumed to be not higher than ±6.1%. The specific electrical resistivity was determined within the 1200 to 2200°K range by the compensation method using direct current. Heating of the sample was effected by electron bombardment. The uncertainty in the measurements of the specific electrical resistivity equalled ±1.5 + 2%. Every investigation was carried on in vacuum as low as 10^{-5} torr. The results of the studies were compared with data from the special literature. Good agreement for the transfer properties of both poly crystal and single crystal tungsten was found. (auth)

19415 (CONF-691002–, pp 326–35) THERMAL DIFFUSIVITY OF HIGH-PURITY THORIUM. Anderson, R. L.; Grotzky, D. H.; Kienzle, W. E. (Ames Lab., Iowa).

The thermal diffusivity and the electrical resistivity have been measured as functions of temperature, between 120 and 1000°K for high purity thorium metal. Thermal diffusivity measurements were made using a linear finite rod method. Results are compared with data of other investigators for lower purity samples. Thermal conductivity values calculated using the thermal diffusivity data of this investigation and published specific heat data are compared with low-temperature thermal conductivity data recently reported by other investigators. (auth)

19416 (CONF-691002–, pp 336–40) TEMPERATURE DEPENDENCE OF THERMAL CONDUCTIVITY AND TEMPERATURE CONDUCTIVITY OF TANTALUM AND NIOBIUM. Pozdnyak, N. Z. (Vsesoyuznyi Zaochnyi Politekhnicheskii Institut, Moscow (USSR)).

The methods of fabrication, and the chemical composition of experimental specimens of powder metallurgy tantalum and niobium are reviewed. A scheme of unit arrangement for measuring temperature conductivity is given. The quantitative values of temperature dependence of thermal conductivity and temperature conductivity of tantalum and niobium within temperature range of 273 to 1273°K are also shown. (auth)

19417 (COO–1778–4) INTERGRANULAR BRITTLENESS STUDIES IN W USING AUGER SPECTROSCOPY. Joshi, A.; Stein, D. F. (Minnesota Univ., Minneapolis. School of Mineral and Metallurgical Engineering). 2 Feb 1970. 16p. Dep. CFSTI.

Results of an investigation aimed at understanding the problem of brittleness in powder metallurgy tungsten by utilizing Auger Electron Emission Spectroscopy as a tool for direct chemical analysis of fracture surfaces are reported. Substantial segregation of P to the grain boundaries was observed in tungsten and the concentration of P can be related to the ductile-brittle transition temperatures. The amount of segregation was dependent upon the grain size- the larger the grain size, the greater the concentration of P at the grain boundary and the associated embrittlement. (auth)

19418 (LMEC–69–36) SOLUBILITY AND DIFFUSIVITY OF INERT GASES IN LIQUID SODIUM, POTASSIUM, AND NaK. Reed, E. L.; Droher, J. J. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 31 Jan 1970. Contract AT(04–3)–700. 32p. Dep. CFSTI.

The literature was surveyed for data on the solubility and diffusivity of rare gases and nitrogen in liquid sodium, potassium, and NaK. Experimental data were found for the solubilities of helium, argon, krypton, xenon, and nitrogen in liquid sodium; solubility data also were found for helium in liquid potassium. Estimates of solubility were made for the solubility of helium and of argon in eutectic NaK. Nitrogen appears to dissolve as the dimer, while the rare gases dissolve as the monomer. The solubilities of rare gases increased in a consistent manner with decreasing atomic radius of the rare-gas solute atom; conversely, the solubility of a given gas decreased with decreasing atomic radius of the solvent liquid-metal atom. Diffusivity values were calculated for the systems of interest using the Stokes–Einstein equation, derived from Fick's Law. (auth)

19419 (ORNL-4512, pp 7-69) INVESTIGATION OF UNIRRADIATED MATERIALS. (Oak Ridge National Lab., Tenn.).

Efforts devoted to inspection, characterization, variability determinations, transition temperature investigations, fracture mechanics studies, and fatigue propagation tests are summarized for specimens of unirradiated heavy-section Type A543 steel. (J.R.D.)

19420 (ORNL-4512, pp 94-115) PRESSURE VESSEL INVESTIGATIONS. (Oak Ridge National Lab., Tenn.).

Development of programs to investigate complex stress states in pressure vessel steels is described. Other aspects of the program include evaluation of data from proof testing, planning and conducting pressure vessel tests, and investigation of safety problems. Activities have been directed primarily toward development of epoxy models of intermediate test vessels. Descriptions of simulated service tests conducted in preparation for large tensile tests are described. Test equipment development is also described. (J.R.D.)

19421 (ORNL-TM-2800) FACTORS AFFECTING THE SWELLING DURING DEGASSING OF COMPACTS CONTAINING URANIUM-ALUMINUM INTERMETALLICS DISPERSED IN ALUMINUM. Chakraborty, A. K.; Crouse, R. S.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 26p. Dep. CFSTI.

Swelling of dispersions of $UA1_3$ in aluminum was investigated by dilatometry, measurement of gas evolution, electrical conductivity, heating-stage metallographic examination, and electron-beam microprobe analysis. The swelling occurs in two stages. In the first, the swelling is gradual and believed to be due to adsorbed gases that are released from the surfaces of the aluminum and $UA1_3$ powder particles. After a varying "incubation time," the second stage of swelling at a greatly increased rate begins. This incubation period increases with increasing $UA1_3$ particle size and decreasing temperature. The second stage is due to the transformation of the $UA1_3$ to $UA1_4$ through reaction with the aluminum matrix. The stability of $UA1_3$ containing either Si, Ge, Sn, or Zr was investigated. These results show silicon and germanium to be the most effective stabilizers within the range of approximately 5 to 6 wt %. Tin was effective at approximately 1.5 wt %, but higher concentrations were detrimental. Zirconium was ineffective for concentrations up to approximately 6 wt %, but a 14-wt-% alloy was stable. (auth)

19422 (ORNL-TM-2857) THEORY OF CRACK PROPAGATION DURING TENSION-TENSION FATIGUE IN A MATERIAL EXHIBITING TIME-DEPENDENT PLASTICITY. Gittus, John (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 13p. Dep. CFSTI.

A set of differential equations describing the process of time-dependent crack propagation during tension-tension fatigue was developed. The model of crack extension is that developed by Tomkins, which hypothesizes that plastic deformation in zones ahead of the fatigue crack leads to further loss of cohesion. Therefore, the rate of crack growth depends on the rate of deformation in the plastic zones and on their size. Their size depends on the stress, while the rate of deformation has been calculated from the present author's recent equations for time-dependent plastic deformation in a material containing dislocations that are immobilized and remobilized by reactions whose rates depend on stress and temperature. Solutions of these equations present a quite reasonable picture of tension-tension fatigue in a material that exhibits time-dependent plasticity. Thus, the fatigue crack propagates continuously during each period of constant stress. The rate of propagation per unit length of fatigue crack, $\dot{l}/l$, decreases following a stress increase and increases following a stress reduction, while l itself increases approximately exponentially. The periods at low stress are doubly damaging; not only do they cause further propagation of the crack, but, also, by permitting remobilization of some of the dislocations that were immobilized during the previous period at high stress, they allow crack propagation at an increased rate when the high stress is reapplied. (auth)

19423 (ORO-3262-15) AN INVESTIGATION OF THE RELATION OF DYNAMIC STRAIN AGING TO FLOW STRESS COMPONENTS IN TITANIUM AND ZIRCONIUM. Progress Report. (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). 13 Feb 1970. Contract AT(40-1)-3262. 32p. Dep. CFSTI.

Preliminary results of tensile tests on Ti and Zr conducted over wide ranges of temperatures and strain rates are reported. Parameters of hardening are being used in calculations which are coefficients representing the difference in flow stress between two specific strain intervals. Data on elongation versus temperature are included for Ti and Zr. Results of research are also included on theory of strain relaxation at constant stress, tensile deformation of Zr at 77°K, ductility and damping capacity of Zr, creep of Zircaloy-2, and twinning and slip modes of monocrystalline and polycrystalline Zr. (J.R.D.)

19424 (RN-S-523) SUBCRITICAL CRACK GROWTH IN BERYLLIUM AT -320°F. Green, A. T.; Hartbower, C. E.; Crimmins, P. P. (Aerojet-General Corp., Sacramento, Calif. Nuclear Div.). Oct 1969. Contract SNP-1. 24p. Dep. CFSTI.

Compact tension tests (Manjoine Wedge Opening Loading design) of vacuum-hot-pressed, S200-grade beryllium were conducted at -320°F. Instrumentation included piezoelectric accelerometers and electric-resistance strain gages. The tests were conducted to evaluate the subcritical-crack-growth characteristics of S200-grade beryllium under plane-strain conditions. The stress-wave-analysis technique revealed discontinuous crack growth at -320°F prior to the final plane-strain (K_{Ic}) instability. The crack toughness of the beryllium tested was 16.4 ksi-in.$^{\frac{1}{2}}$ at -320°F. (auth)

19425 DENSITY OF LIQUID URANIUM. Rohr, William G.; Wittenberg, Layton J. (Monsanto Research Corp.; Miamisburg, Ohio). J. Phys. Chem.; 74: 1151-2(5 Mar 1970).

A pycnometric method was used to measure the density of liquid U at 1137 to 1245°C. The significant result of the measurements was that the density of liquid U is less than the density of the solid. (P.C.H.)

19426 HIGH-SPEED (SUBSECOND) MEASUREMENT OF HEAT CAPACITY, ELECTRICAL RESISTIVITY, AND THERMAL RADIATION PROPERTIES OF MOLYBDENUM IN THE RANGE 1900 TO 2800 K. Cezairliyan, A.; Morse, M. S.; Berman, H. A.; Beckett, C. W. (National Bureau of Standards, Washington, D. C.). Contract ISSA-69-0001. J. Res. Nat. Bur. Stand.; 74A: 65-92 (Jan-Feb 1970).

A technique is described for the high-speed measurement of heat capacity, electrical resistivity, hemispherical total and normal spectral emittances of electrical conductors at high temperatures (above 1900°K) with millisecond resolution. Duration of an individual experiment, in which the specimen is heated from room temperature to close to its melting point, is less than one second. Temperature measurements are made with a high-speed photoelectric pyrometer. Quantities are recorded by a high-speed digital data acquisition system which has a resolution of approximately one part in 8000. Time resolution of the entire system is 0.4 msec. Results on the above properties of molybdenum in the temperature range 1900 to 2800°K are reported and are compared with those in the literature. Estimated inaccuracy of measured properties in the above temperature range is: 2 to 3% for heat capacity, 0.5% for electrical resistivity, 3% for hemispherical total emittance, and 2% for normal spectral emittance. (auth)

19427 THE EFFECT OF ADDITIONS OF VANADIUM, MOLYBDENUM, TUNGSTEN, SILICON, TIN, AND CHROMIUM ON THE ELINVAR PROPERTY OF NICKEL AT HIGH TEMPERATURE. Masumoto, Hakaru; Sawaya, Shohachi; Nakamura, Naoji (Research Inst. of Electric and Magnetic Alloys, Sendai). Trans. Jap. Inst. Metals; 10: 421-5(Nov 1969).

Measurements of the linear coefficient of thermal expansion, Young's modulus and its temperature coefficient, and density were carried out at elevated temperatures to investigate the variation of the anomaly in Young's modulus of nickel at high temperature, the so-called Elinvar property, with additions of vanadium, molybdenum, tungsten, silicon, tin, and chromium. The results of these measurements indicate that in all the alloy systems investigated the temperature at which the Elinvar property appears, falls to room temperature along the magnetic transformation point with increasing content of each additive element. Also, a minimum linear coefficient of thermal expansion, the so-called Invar property, is observed around a composition where the Elinvar property occurs. (auth)

19428 EFFECT OF PARTICLE SIZE DISTRIBUTION ON THE FRICTION IN A POWDER MASS. Riley, Robert E.; Hausner, Henry H. (Los Alamos Scientific Lab., N. Mex.). Int. J. Powder Met.; 6: 17-22(Jan 1970).

The characteristics of a powder can be very misleading when compared on the basis of average particle size. Friction behavior in a powder is shown to be less dependent upon average size and more dependent upon particle size distribution and its related parameter specific surface. (auth)

19429 SUPERPLASTICITY IN P/M IN-100 ALLOY. Reichman, S. H.; Smythe, J. W. (Federal-Mogul Corp., Ann Arbor, Mich.). Int. J. Powder Met.; 6: 65-75(Jan 1970).

Powder metallurgy (P/M) IN-100 superalloy was produced which showed strong superplastic behavior. The low interstitial impurity powder was identified by extrusion, below the recrystal-

lization range for the alloy and the adiabatic heating from the process resulted in a recrystallized fine grained structure. The proposed mechanism for the superplasticity in P/M IN-100 is the migration of the second phase gamma-prime particles. Subsequent to superplastic deformation the grain size was grown sufficiently to stop the superplastic propensity of the alloy. Tensile properties from room temperature to 1950°F are equal to or above those of the cast alloy. (auth)

19430 STRUCTURE AND MAGNETIC PROPERTIES OF RAPIDLY QUENCHED SAMARIUM-TYPE ALLOYS. Speight, J. D. (California Inst. of Tech., Pasadena). J. Less-Common Metals; 20: 251-62(1970).

Lattice spacing and magnetic susceptibility measurements have been made for Sm-type alloys in the Gd–La, Gd–Ce, Gd–Pr and Gd–Nd systems, in both the equilibrium and liquid quenched states. In all cases the liquid quenched alloys adopt the close-packed hexagonal structure. Magnetic ordering, with incomplete cancellation of the atomic moments, has been observed in all the alloys at low temperatures (T < 200°K). The magnetic ordering is discussed in terms of interactions between the constituent moments of the alloys. (auth)

19431 LOW TEMPERATURE THERMALLY ACTIVATED DEFORMATION IN Nb-6 a/o W SINGLE CRYSTALS. Koss, Donald A. (Pratt and Whitney Aircraft, Middletown, Conn.). Scr. Met.; 4: 203-7(Mar 1970).

Data are presented on thermally activated flow of Nb–6 at. % W single crystals which indicate that more than one mechanism controls the rate of deformation. It appears that at least two mechanisms control at low temperatures. These processes appear to be related since the process with the smallest activation energy controls flow at a given stress. (J.R.D.)

19432 URANIUM ALLOY. Lerouge, Georges (to Commissariat a l'Energie Atomique). British Patent 1,183,780. 11 Mar 1970. Priority date 11 Aug 1967, France.

The modification of uranium alloys is described for use in the manufacture of nuclear fuel elements. The object is to further improve the properties of such alloys, especially their mechanical properties during irradiation. The additions of small quantities of certain metal elements refine the uranium structure, reduce the grain size, and render the grain dimensions more uniform. The U alloy is more stable during irradiation, but the neutron absorption properties are not substantially modified. The alloy contains 0.02 to 0.15% by weight of tin and 0.02 to 0.08% by weight of Cr or Fe, the balance U and impurities. A modification contains 0.02 to 0.2% by weight of Al. Either of the above alloys may also contain 0.02 to 0.15% by weight of Si. (J.C.W.)

19433 GASEOUS METAL BORIDES. I. ON THE DISSOCIATION ENERGY OF THE MOLECULES ThB, ThP, AND Th_2, AND PREDICTED DISSOCIATION ENERGIES OF SELECTED DIATOMIC TRANISTION-METAL BORIDES. Gingerich, Karl A. (Texas A and M Univ., College Station). High Temp. Sci.; 1: 258-67 (Jul 1969).

The gaseous equilibria over a thorium–boron alloy that contained a small amount of phosphorus have been studied at 2804°K, using a combination of effusion and mass spectrometric techniques. From the experimentally determined enthalpies of various reactions, combined with published thermodynamic data, the following dissociation energies have been obtained: $D_0^\circ(ThB) = 70 \pm 8$ kcal/mole, $D_0^\circ(ThP) = 89 \pm 7.0$ kcal/mole, and $D_0^\circ(Th_2) \leq 68 \pm 8$ kcal/mole. The heat of formation of gaseous ThB was determined as $\Delta H_{f,298}^\circ = 200 \pm 13$ kcal/mole. The dissociation energies of diatomic borides of selected electropositive transition metals have been estimated on the basis of empirical correlations by Colin and Goldfinger and by Pauling. The values, which range from 65 kcal/mole for ScB to 80 kcal/mole for ZrB are in a first approximation understood in terms of the Pauling model of a single covalent bond to which a small ionic resonance contribution is added. (auth)

19434 ROLLING TEXTURE OF Pu-3.4 AT. PERCENT Ga. Moment, R. L.; Schindler, J. E. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Met. Trans.; 1: 157-62 (Jan 1970).

The rolling texture of a Pu-3.4 at.% Ga alloy was measured as a function of reduction. Both (111) and (200) pole figures were plotted from reflection data for specimens rolled 70, 80, 90, and 95% at room temperature. The texture developed smoothly and at all reductions bore a good resemblance to that of copper. At 95% reduction there was a strong ⟨111⟩ pole located 20° to either side of the rolling plane normal in the rolling direction, and the central pattern generally resembled an ellipse whose major axis lay in the cross direction. However, the spread of (111) pole intensity led to interpretation of the pole figures in terms of a spread of orientations. Paired axes of rotation are used to describe this spread. In the early states of reduction the distribution of grain orientations can best be described by a rotation about the two strong ⟨111⟩ poles located to either side of the rolling plane normal in the rolling direction. As deformation proceeds two distinct orientations develop, related by rotations about these ⟨111⟩ poles, but the pole figure does not show all the associated ⟨111⟩ poles as expected. This can be explained by a spread of orientations, about a set of ⟨110⟩ poles, that decreases with deformation. At 95% reduction the missing ⟨111⟩ poles in the pole figure appear, though they are not as sharp as the others. (auth)

19435 EFFECT OF INTERSTITIAL SINKS ON CREEP OF A DISPERSION STRENGTHENED COLUMBIUM-BASE ALLOY. Klein, M. J.; Gulden, Mary Ellen (International Harvester Co., San Diego, Calif.). Met. Trans.; 1: 105-10(Jan 1970).

The effects of interstitial sinks on the structure and creep behavior of the dispersion-strengthened niobium base alloy, D43 were examined. Interstitial sinks changed the structure of the alloy and rendered it less creep resistant by reducing the carbon concentration and, therefore, the volume fraction of the dispersed phase. Where the interparticle spacing was small (<~1 μ) the alloy was strengthened by the direct interaction of dislocations with particles. Where the interparticle spacing was large, subgrains were probably a more important structural feature strengthening the alloy. The creep rate can be described by the empirical expression $\dot{\epsilon} = A\sigma^n e^{-H/RT}$, where H (106 to 112 kcal per mole) and n (7.7 to 8.3) are independent of the amount of dispersed phase, and A is proportional to the reciprocal carbon concentrations in the range 100 to 800 ppM. (auth)

19436 CORRELATION OF GAMMA–GAMMA PRIME MISMATCH AND STRENGTHENING IN Ni/Fe–Ni BASE ALLOYS CONTAINING ALUMINUM AND TITANIUM AS HARDENERS. Maniar, G. N.; Bridge, J. E. Jr.; James, H. M.; Heydt, G. B. (Carpenter Tech. Corp., Reading, Pa.). Met. Trans.; 1: 31-42 (Jan 1970).

Various authors have invoked coherency strains and disregistry between the crystal lattices of the matrix and γ'-strengthened superalloys. Hagel and Beattie correlated the mode of precipitation with the degree of its lattice mismatch. Heydt and Whitney used this approach during the development of an Fe-Ni base high temperature alloy. To understand the role of such a relationship, an investigation of a few experimental Ni-base/Fe–Ni base alloys was carried out. These alloys were strengthened by variable titanium, aluminum, and molybdenum additions and contained chromium. Lattice parameters of the solution treated and aged samples were measured. The γ' phase was electrolytically extracted for lattice parameter determinations, and γ-γ' mismatch calculated. The γ-γ' mismatch was correlated with room temperature hardness and stress rupture properties at 1200°F. The influence of alloying additions, matrix and γ' lattice parameters were interrelated. (auth)

19437 PRESSURE DEPENDENCE OF THE ELASTIC CONSTANTS OF BERYLLIUM AND BERYLLIUM–COPPER ALLOYS. Silversmith, Donald J.; Averbach, B. L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., B; 1: 567-71(15 Jan 1970).

The elastic constants of beryllium and of alloys containing 1.1 and 2.4 wt % copper (0.16 and 0.35 at. %) have been measured by a pulse-echo-overlap method. These stiffness coefficients in units of 10^{12}dyn/cm^2 are:

Crystal	C_{11}	C_{33}	C_{44}	C_{12}	C_{13}
Be	2.954	3.561	1.706	0.259	−0.01
Be–1.1% Cu	2.948	3.597	1.702	0.278	...
Be–2.4% Cu	2.931	3.552	1.731	0.301	0.03

The effect of hydrostatic pressures up to 6 kbar is indicated by the pressure derivatives given below:

Crystal	dC_{11}/dP	dC_{33}/dP	dC_{44}/dP	dC_{12}/dP	dC_{13}/dP
Be	6.92	8.98	2.55	2.76	3.3
Be–1.1% Cu	7.13	7.79	2.62	2.86	...
Be–2.4% Cu	12.01	13.42	2.58	7.73	−2.8

The coefficient $C_{13} = -0.01$ is unusual for a metal; this value indicates that there is no coupling between a tensile stress along the c axis and a resolved stress in the basal plane. This anisotropy in the bonding mechanisms for the two principal directions has been correlated with the band structure and may account for the relatively easy cleavage of beryllium along the basal plane. (auth)

19438 PRECIPITATION OF HYDRIDES IN TITANIUM ALLOYS. Boyd, J. D. (Battelle Memorial Inst., Columbus, Ohio). ASM (Amer. Soc. Metals), Trans. Quart.; 62: 977-88(Dec 1969).

Homogeneous and heterogeneous precipitation of hydrides in Ti-8Al-1Mo-1V was studied by transmission electron microscopy. Because there is a considerable activation energy for hydride nucleation in this alloy, a critical hydrogen concentration of approximately 800 ppM is required before spontaneous nucleation will occur. At lower hydrogen concentrations the nucleation barrier can be overcome by a small amount of plastic strain, and hydrides will nucleate on the $\{10\bar{1}0\}\langle\bar{1}2\bar{1}0\rangle$ slip bands. The crystal structure and orientation of the strain-induced hydrides is such that the edge-components of the $a/3\langle\bar{1}2\bar{1}0\rangle$ glide dislocations in the α matrix can act as interface dislocations and constitute a semi-coherent interface between the hydride and matrix phases. Dissolution of the strain-induced hydrides was studied directly in the electron microscope by beam heating. Dissolution takes place by the edgewise movement of ledges parallel to the habit-plane interfaces. (auth)

19439 GENERALIZED MODEL FOR HYDROGEN EMBRITTLEMENT. Westlake, D. G. (Argonne National Lab., Ill.). ASM (Amer. Soc. Metals), Trans. Quart.; 62: 1000-6(Dec 1969).

The proposed, generalized model is based on the premise that the hydrogen embrittlement of any metal can be explained in terms of localized formation of a phase whose mechanical properties differ from those of the matrix because of hydrogen enrichment. Both endo- and exothermic occluders of hydrogen are discussed and it is argued that previously proposed, seemingly conflicting models are not incompatible. Some consequences of the model are suggested and experimental evidence is presented to justify the model. (auth)

19440 CHEMICAL DIFFUSIVITIES OF DELTA STABILIZED Pu–Zr ALLOYS. Harvey, M. R.; Rafalski, A. L.; Riefenberg, D. H. (Dow Chemical Co., Golden, Colo.). ASM (Amer. Soc. Metals), Trans. Quart.; 62: 1014-15(Dec 1969).

Chemical diffusivities in the δ phase of Pu–4.2 at. % Zr and Pu–11.4 at. % Zr alloys were determined at 351 to 475°C. (G.M.C.)

19441 STRENGTHENING OF MP ALLOYS DURING AGING AT ELEVATED TEMPERATURES. Graham, A. H. (E. I. du Pont de Nemours and Co., Wilmington, Del.). ASM (Amer. Soc. Metals), Trans. Quart.; 62: 930-5(Dec 1969).

The effect of aging treatments on mechanical properties was investigated for MP Alloys containing 35 to 60% Co, 10 to 35% Ni, 20% Cr, and 10% Mo. The yield strength of cold worked alloys increased about 20% to 30% during aging at temperatures ranging from 800 to 1,000°F. Cold working was a necessary condition for significant strengthening during aging. The aging of a cold worked 35Co: 35Ni alloy was studied by electrical resistivity measurements as well as electron and x-ray diffraction techniques. The proposed mechanism of strengthening during aging involves the diffusion of Mo atoms to hcp platelets formed during cold working and the formation of a coherent embryo of a Co_3Mo precipitate. The retention of strength in alloys after overaging at 1200°F was attributed to a dispersion strengthening effect of the fine Co_3Mo precipitate. (auth)

19442 STRENGTHENING MECHANISMS IN DISPERSION HARDENED NICHROME. Webster, D. (Boeing Co., Seattle). ASM (Amer. Soc. Metals), Trans. Quart.; 62: 936-48(Dec 1969).

The strengthening mechanisms in dispersion hardened nichrome (TDNiC) were examined at temperatures between 70 and 2,000°F. Four strengthening mechanisms were observed: grain refinement; solid solution hardening; dispersion hardening; and dislocation substructure hardening. The last three mechanisms were operative at all temperatures but grain refinement produced a weakening effect above 800°F. Deformation in tension was found to produce voids around thoria particles at temperatures up to 2,200°F. The contribution of dispersion hardening below 1,000°F can be predicted from models based on the Orowan bowing of dislocations although fracture of some thoria particles was observed. Dislocation substructure becomes increasingly important as the temperature is increased and at 2,000°F it is the major strengthening factor. (auth)

19443 DYNAMIC STRAIN AGING DURING THE CREEP OF A Mo–Ti–C ALLOY. Raffo, Peter L. (Lewis Research Center, Cleveland). ASM (Amer. Soc. Metals), Trans. Quart.; 62: 846-51(Dec 1969).

A study was made of the influence of dynamic strain aging on the creep of Mo–0.82Ti–0.20C (at. %) alloy. The stress and temperature dependence of the creep rate above 2,400°F were identical to that observed for unalloyed molybdenum. At 1,800°F, the creep behavior was affected by the simultaneous precipitation of carbides. This precipitation apparently lowered the density of mobile dislocations. (auth)

19444 COLD ROLLING CHARACTERISTICS OF ALUMINUM–BORON FIBER COMPOSITES. Getten, J. R. (IBM Corp., Endicott, N. Y.); Ebert, L. J. ASM (Amer. Soc. Metals), Trans. Quart.; 62: 869-78(Dec 1969).

The transverse deformation characteristics of uni-directionally reinforced aluminum-boron fiber composites were investigated by cross-rolling composite panels various amounts at ambient temperature and measuring the hardness and tensile properties in a direction parallel to the fibers. Panels containing boron fiber volume fractions of 16, 30, and 44.5% were cross-rolled in steps of either 10 or 20% reduction in thickness to a maximum of 90% total reduction. Unreinforced panels of the aluminum matrix material were also given the same processing for control and reference purposes. The results indicated that cold working by cross-rolling had a beneficial effect in raising the tensile strength of the composites, and in increasing the strain range over which the initial totally elastic strain response persisted. The optimum amount of cold work seemed to be correlated with the onset of significant amounts of fiber breakage during the cold working operation. It is suggested that the beneficial effects of the cold work are the result of the strain hardening of the matrix and the mechanical relief of the residual stresses that existed in the as-fabricated panels. (auth)

19445 AXIAL CREEP AND STRESS-RUPTURE OF B–Al COMPOSITES. Breinan, Edward M.; Kreider, Kenneth G. (United Aircraft Research Labs., East Hartford, Conn.). Met. Trans.; 1: 93-104(Jan 1970).

Constant load creep and stress-rupture properties of boron and silicon carbide coated boron, BORSIC, filament reinforced aluminum alloys were measured at 300, 400, and 500°C. The mean stresses for 1000 hr rupture life at the three text temperatures were 96,000, 82,000, and 72,000 psi, respectively. Elongation in creep tests was checked by using scribed lines, and this technique indicated that grip-mounted extensometers were inadequate for precision measurement due to shear of aluminum in the grips. A maximum of 0.2% plastic elongation was measured, which corresponded to the creep properties of the filaments. Comparison of Borsic composite results with data for composites fabricated with uncoated boron filament showed that the short-time rupture strengths of the two materials were similar, but that the stress for rupture of the boron filament composites decreased much more rapidly with increasing rupture time than did the stress for rupture in the Borsic filament composites, due to degrading reactions of the uncoated boron with the matrix. Fracture analysis was performed using optical metallography and scanning electron microscopy. The analysis indicated that the major portion of filament failures in the region of the fracture surface at elevated temperatures initiated at the outer surface of the filament, whereas filament failures that initiated in the region of the core were more common in room temperature tensile specimens. The amount of plastic flow in the matrix increased markedly with increasing temperature, but filament pullout lengths were far less than those predicted by a simple shear-lag theory on the basis of the shear strength of the matrix. (auth)

19446 MARTENSITE CHROMIUM (13 PERCENT Cr) AND AUSTENITE Cr–Ni STEEL ALLOY TYPE 18/8. Gorjup, Zvonimir. Nukl. Energ.; 5: No. 3-5, 59-62(1968–69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

Martensite cast steel was studied on the basis of chromium content which had to be kept accurate within the determined limits to obtain pure martensite structure. A toughness of 4 kpm/mm^2 was practically impossible to obtain and weldability was very bad and hot cracks were hard to avoid. A 10 years investigation removed these deficiencies. Cast steels were obtained with considerably better mechanical properties especially tensile strength, yield point and impact strength from 4 to 8 kpm/mm^2, with good weldability. The production of new shapes for runners, blades, casings, cylinders, fittings and other vital parts of water and steam turbines was successful. It is suggested that these more modern low carbon steels be used instead of the classic alloys of this type for future nuclear engineering equipment design. (auth)

19447 CATALYZED DISPROPORTIONATION OF CARBON MONOXIDE. Walker, P. L. (Pennsylvania State Univ., University Park); Thomas, J. M. Carbon; 8: 103-4(Feb 1970).

A preliminary survey was made of the deposition of carbon from CO–H_2 mixtures onto solid surfaces, using time-lapse cinematography. The catalytic behaviour of Fe, Co, Ni, Pt, and quartz is described. (auth) (UK)

19448 KINETICS OF THE EMISSION OF STORED ENERGY IN DEFORMED URANIUM. Golovanov, Yu. N.; Sitnikov, A. F.; Tsvetaev, A. A.; Chuzhko, R. K. (Inst. of Physical Chemistry,

Moscow). Dokl. Akad. Nauk SSSR; 189: 993-5(11 Dec 1969). (In Russian).

The energy emission from deformed (25% compression) uranium alloys containing 2×10^{-2} to 3×10^{-3} weight % iron was determined on annealing the alloy in a differential adiabatic calorimeter. The stored energy was evolved in five distinct stages. The total thermal effect increased from 54 to 61 cal/gram-atom with increasing iron content of the alloy. These values are higher than those of other fcc metals such as 8.8 cal/g-atom for copper and about 15 cal/g-atom for nickel. It can be assumed that a larger number of defects are formed in uranium than in copper or nickel at comparable deformations. The activation energies for the 5 stages were 0.75, 1.05, 1.30, 1.40 and 1.6 eV with increasing temperature. The reactions were first-order except for the 5th stage which was between a first and second order reaction. The evolution of energy in the 5th stage is due to recrystallization processes. The fourth stage is probably due to a polygonization process. The first three stages are due to the migration of vacancies and disappearance at dislocations, edges and individual grains. The concentration of vacancies is estimated at 0.06% in the alloy with the least amount of iron impurity and 0.10% in the alloy with the largest amount of iron impurity. (TTT)

19449 ANALYSIS OF DATA ON NON-PROPAGATING FATIGUE CRACKS ON A FRACTURE MECHANICS BASIS. Harrison, J. D. (Welding Inst., Cambridge, Eng.). Metal Constr. Brit. Weld. J.; 2: 93-8(Mar 1970).

From an assessment of published work on non-propagating fatigue cracks associated with welded joints, it was concluded that the experimental results can be represented by a law stating that cracks will only propagate if the range in fracture mechanics stress-intensity factor, K, exceeds a certain value. Moreover, if the critical value is expressed in terms of K/E, the range in K divided by Young's modulus, the results for a number of Cu alloys, Ni alloys and steels, fall within a narrow scatter band between 1.5×10^{-4}/in.$^{\frac{1}{2}}$ and 1.8×10^{-4}/in.$^{\frac{1}{2}}$. For all materials tested, with the exception of pure Al, cracks will not propagate if $K/E < 1 \times 10^{-4}$/in.$^{\frac{1}{2}}$. (UK)

19450 EFFECT OF CARBON ON THE HIGH TEMPERATURE PROPERTIES OF TYPE 304 and 316 AUSTENITIC STEELS. Yoshida, Heitaro; Yoda, Renpei; Koike, Kisaburo (National Research Inst. for Metals, Tokyo). Tetsu To Hagane; 56: 311-30(Feb 1970). (In Japanese).

Type 304, 347, and 316 austenitic stainless steels are used as the tubing for nuclear fuel cladding in fast reactors. In the future, plutonium carbide for nuclear fuel and liquid sodium for coolant would be used. As a result tubing for nuclear fuel cladding was carburized, and it would become a problem whether high temperature properties are affected. From this standpoint, the effect of carbon on high temperature properties of Type 304 and 316 austenitic steels was investigated. Results obtained are as follows: When these alloys were solution treated at 1150°C, solution hardness, deformation resistance at 900, 1000, and 1100°C, and tensile strength and yield strength at room temperature, 600, 700, and 800°C tended to increase nearly in proportion to carbon content, but the recrystallization temperature, and 10,000 hr creep rupture strength at 600, 700, and 800°C showed a maximum at about 0.2% carbon content. It is believed that the behavior of the recrystallization temperature and creep rupture strength are due to excellent solution hardening and precipitation hardening, because residual carbide particles in the alloy containing more than 0.2% carbon caused precipitates to form around it in heating at high temperature, and caused solution strengthening and precipitation strengthening to lower. But, when the solution temperature was 1200°C, the maximum creep strength was obtained for greater than 0.3% carbon and the strength improvement was small and the ductility lowered. Therefore, the upper limits of carbon content and solution temperature are considered to be about 0.2% and 1150°C, respectively. (auth) (NSA of Japan)

19451 MASS SPECTROMETRIC STUDIES OF PLUTONIUM COMPOUNDS AT HIGH TEMPERATURES. III. THE VAPOR PRESSURE OF PLUTONIUM. Kent, R. A. (Los Alamos Scientific Lab., N. Mex.). High Temp. Sci.; 1: 169-75(Jul 1969).

A mass spectrometric-Knudsen effusion study has shown that, in the temperature range 1426 to 1658°K, liquid plutonium vaporizes predominately to the monomer with the vapor pressure given by the least-squares equation $\log_{10} P_{Pu}(atm) = (4.924 \pm 0.120) - 17{,}420 \pm 184/T°K$. The heat and entropy of vaporization are $\Delta H^{\circ}_{298} = 83.0 \pm 0.5$ kcal mole^{-1} and $\Delta S^{\circ}_{298} = 29.1 \pm 0.5$ eu. (auth)

19452 A MASS SPECTROMETRIC STUDY OF THE ENTHALPY OF SUBLIMATION OF TECHNETIUM. Krikorian, O. H.; Carpenter, J. H.; Newbury, R. S. (Univ. of California, Livermore). High Temp. Sci.; 1: 313-30(Oct 1969).

Mass-spectrometric measurements of the intensities of Tc^+ and Mo^+ were compared and used to derive vapor pressures and the enthalpy of sublimation of technetium. Samples of technetium and molybdenum were heated to 1900 to 2300°K in separate compartments of a rhenium heater. Because of radiological hazards, the technetium (^{99}Tc) was limited to a sample size of about 1 mg, and special techniques had to be developed to make measurements. The sample heater was a small tubular filament placed very close to the ionization source in order to limit the spread of contamination, and to enhance the sensitivity of detection. Vapor pressures of technetium were determined from the relative intensities of Tc^+ and Mo^+ and the known vapor pressures of molybdenum. In similar experiments, comparisons were made of the vapor pressures of niobium and molybdenum, and among niobium, ruthenium, and molybdenum. The ΔH°_{298} of sublimation of technetium from a third-law treatment was 158 ± 4 kcal/g-atom as compared to 157.5 ± 0.4 kcal/g-atom for molybdenum. By similar treatments, the enthalpies of sublimation of niobium and ruthenium were found to be somewhat higher than the literature values. A detailed analysis is given of the systematic and random errors in this work. In auxiliary experiments, the normal spectral emittance of rhenium at 6500 Å was found to be $\epsilon_{Re} = 0.465 - 0.032 \times 10^{-3}$ T, and for molybdenum, $\epsilon_{Mo} = 0.429 - 0.035 \times 10^{-3}$ T, where T is in °K. (auth)

19453 UNIDIRECTIONAL SOLIDIFICATION OF Cu–ZrCuSi ALLOYS. Nickl, Julius J.; Sprenger, Heinz (Univ., Munich). Z. Metallk.; 61: 229-30(Mar 1970). (In German).

The growth of the pseudo-binary eutectic Cu-ZrCuSi produced a composite giving a matrix-strengthening of three times. The good mechanical properties of the composite are due to the small solubility of zirconium and silicon in copper. The elctrical conductivity of the alloy was nearly the same as of pure copper. (auth)

19454 PRECIPITATION MODE IN Co–10 AT. PERCENT Be ALLOY. Yagisawa, Kohei; Yoshida, Hidehiko (National Research Inst. for Metals, Tokyo). Jap. J. Appl. Phys.; 9: 161-73(Feb 1970).

Aging behavior of Co–10 at. % Be alloy was investigated with Vickers hardness measurement, and x-ray, optical, and electron microscopy. In the specimen quenched from homogenizing temperature, hcp and retained fcc matrices exist. Agings were performed at 300, 400, 500, and 600°C. The structure change occurred in the sequence of GP zone formation and three types of discontinuous precipitation. The crystal structure of the precipitate was CoBe of CsCl type. The matrix of the continuously precipitated region above 400°C was supposed to be fcc. The hcp transformation during cooling to room temperature was hindered by the presence of GP zone and precipitates. Besides quench-aging, direct-aging was also conducted after homogenization. Aging sequence was the same as that in fcc matrix of quench-aged specimen. The striation was observed by electron microscope parallel to the traces of {110} planes of the clustered fcc matrix, as in Cu–Be and Ni–Be alloys. (auth)

Structure and Phase Studies

Refer also to abstract 19431.

19455 (CONF-691002–, pp 295-8) THERMAL CONDUCTIVITY OF CERIUM DIOXIDE. Chekhovskoi, V. Ya.; Stavrovskii, G. I. (Akademiya Nauk SSSR, Moscow. Institut Vysokikh Temperatur).

The thermal conductivity of cerium dioxide was measured in the 300 to 1200°C temperature range using an internally heated cylinder. The experiments were conducted in argon atmosphere. The bulk weight of the material to be studied and heated to 1700°C temperature was 6.7 g/cm^3. No experimental data on cerium dioxide thermal conductivity in this temperature range has been available in literature. (auth)

19456 (LA–4367) UNIT CELL OF THE ZETA PHASE OF THE PLUTONIUM–ZIRCONIUM AND THE PLUTONIUM–HAFNIUM SYSTEMS. Zachariasen, W. H.; Ellinger, F. H. (Los Alamos Scientific Lab., N. Mex.). 26 Jan 1970. Contract W-7405-eng-36. 4p. Dep. CFSTI.

The unit cell of the isostructural Pu–Zr and Pu–Hf zeta phases (~3 at. % Zr or Hf) was found to be body-centered tetragonal with a = 18.19 ± 0.01 Å and c = 7.851 ± 0.003 Å. (auth)

19457 (UCRL–19052) THE EFFECT OF STACKING FAULT ENERGY ON THE STRAIN INDUCED MARTENSITE TRANSFORMATION AND TENSILE CHARACTERISTICS IN IRON BASED ALLOYS. Dunning, John S. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec 1969. Contract W-7405-eng-48. 119p. Dep. CFSTI.

Thesis.

Two series of iron based alloys, one carbonless and the second containing carbon, were designed such that a regular variation of stacking fault energy (S.F.E.) in the range 10 to 50 ergs cm^{-2} was obtained while maintaining a constant M_s temperature within each series. The austenitic alloys were transformed to martensite under the influence of tensile strain at cryogenic temperatures. Transformation characteristics were found to vary in a consistent fashion within each series of alloys. In alloys with high S.F.E. the martensite formed during tensile straining formed in massive blocks or large fragmented plates. In low S.F.E. alloys, however, the transformation products observed were extremely fine. In the carbonless series of alloys the presence of ϵ (hcp) phase was detected together with $\alpha-$(bcc) martensite after transformation, in the alloy with lowest stacking fault energy. This indicated the possibility that the sequence of transformation is $\gamma \rightarrow \epsilon \rightarrow \alpha'$ in alloy of low S.F.E. as opposed to $\gamma \rightarrow \alpha'$ in alloys with high S.F.E. The effect of prior deformation on subsequent strain induced transformation varied considerably between the two alloy series. Differences in composition both within and between the two series of alloys resulted in a variation in response to prior deformation. In addition the variation in S.F.E. within each series resulted in the development of different textures after deformation. In carbonless alloys prior deformation did not affect the rate of subsequent transformation. In carbon containing alloys prior deformation resulted in a stimulation of the transformation. The degree of stimulation increased uniformly with increasing S.F.E. in the carbon containing alloys. Transformation rates and the size and distribution of the transformation products were related to the abundance of favorable nucleation points. The nature of the transformation products, and superior deformation characteristics were correlated with superior tensile behavior and transition induced plasticity (TRIP) responses in alloys with low S.F.E. In low S.F.E. carbon containing alloys tensile strengths of 250,000 to 320,000 psi with elongations of 66 and 31% were recorded at cryogenic temperatures. (auth)

19458 RESPONSE OF ETCHED NIOBIUM AND NIOBIUM ALLOYS TO POLARIZED LIGHT. Trenouth, J. M.; Grzedzielski, M. S. (National Research Council of Canada, Ottawa). J. Less-Common Metals; 20: 269-72(1970).

Development of techniques to promote enhanced grain contrast in Nb and in Nb alloys B66 and Fs 85 for examination in polarized light is discussed. Investigation results show that a grooved surface structure is responsible for grain contrast in these alloys and metals. (J.R.D.)

19459 STRUCTURE IN THE SYSTEM Pt-Zn-Cd. Khan, Y.; Schubert, K. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 20: 266-8(1970). (In German).

The crystal structure was determined from powder x-ray analysis for $Pt_{50}Zn_{38}Cd_{30}$, $Pt_{37.5}Zn_{55}Cd_{7.5}$, and $Pt_{34}Zn_{22}Cd_{44}$. Lattice parameter data are tabulated and discussed. (J.R.D.)

19460 SHORT RANGE ORDER OF Ta-Mo BCC ALLOYS. Predmore, R.; Arsenault, R. J. (Univ. of Maryland, College Park). Scr. Met.; 4: 213-17(Mar 1970).

Results of an x-ray diffraction investigation conducted to determine the nature of Ta and Mo atomic distribution in bcc solid solutions are presented. It is noted that short range ordering and size effects in a wide range of Ta-Mo alloy compositions are primarily responsible for the cleavage fracture in the central portion of the Ta-Mo binary diagram. (J.R.D.)

19461 DETERMINATION OF VARIOUS Mo(110) AND W(110) SURFACE STRUCTURES FROM LEED RESULTS USING A MULTIPLE-SCATTERING METHOD. Gafner, G. (Council for Scientific and Industrial Research, Pretoria). Surface Sci.; 19: 9-20(Jan 1970).

A plane wave multiple scattering method employing simplified form factors has been used to determine the surface structure of annealed (110) faces of tungsten and molybdenum from existing LEED results. Assuming the validity of the method, it is found that these faces, after being annealed under LEED conditions, are probably covered by an overgrown monolayer sited directly above, and at a distance of 2.1 Å from the terminal layer of the bulk structure. It is shown that ion bombardment removes this overgrown layer and reveals the bulk structure of Mo(110). Adsorbed CO on bombarded Mo(110) is shown to take up the α-sites, i.e., to position itself directly above the metal atoms, and assuming similar form factors for the atoms in the adsorbate and adsorbent, to cover 60% of the surface. (auth)

19462 MORPHOLOGY AND REAL STRUCTURE OF MOLYBDENUM SINGLE CRYSTALS PREPARED BY THERMAL DECOMPOSITION OF MOLYBDENUM PENTACHLORIDE FROM THE GAS PHASE. Weise, G.; Guenther, R. (Deutsche Akademie der Wissenschaften, Berlin. Institut fuer Metallphysik und Reinstmetalle, Dresden). J. Cryst. Growth; 6: 167-83(Jan-Feb 1970). (In German).

Homogenous (crackless) single crystals of molybdenum with ⟨110⟩-, ⟨100⟩- and ⟨111⟩-orientation of the rod axis are prepared under suitable growth conditions by chemical vapor depositions. The presupposition for the formation of crackless monocrystals is a growth over macroscopic smooth limit faces. These interactions between morphology and real structure are demonstrated by surface photographs and metallographic examinations. The homogenous monocrystals obtained by high supersaturations are limited by {110}-, {100}-, {211}- and {111}-faces corresponding to the orientation of rod axes. These flat grown faces could be regarded as equilibrium form faces. The number of equilibrium form faces is reduced by lower supersaturations. The faces with higher specific free surface energy show coarsening of subindividuals, which are built up by steps of equilibrium form faces. The real structure of the crystals is dependent on the growth conditions and shows characteristic disturbances by cracks and subgrain boundaries. They are initiated in the edges of limit faces and concave edges of steps as a consequence of the supersaturation inhomogeneities. (auth)

19463 NUCLEATION OF ALUMINUM GRAINS IN ALLOYS OF ALUMINUM WITH TITANIUM AND BORON. Davies, I. G.; Dennis, J. M.; Hellawell, A. (Oxford Univ.). Met. Trans.; 1: 275-80(Jan 1970).

The microstructure of a ternary alloy, Al-5 wt % Ti, 1 wt % B, was examined by optical and electron transmission microscopy, by selected area diffraction, and electron probe microscopy, by selected area diffraction, and electron probe microanalysis. Particles of Al_3Ti were found at the center of grains and there existed preferred epitaxial orientations between this compound and the surrounding aluminum. Particles containing titanium and boron occurred at aluminum grain boundaries and had no preferred configurations with respect to the aluminum or to one another. It is concluded that the active heterogeneous nuclei are therefore Al_3Ti and that particles of TiB_2, AlB_2, or a ternary compound are not active in this alloy. Grain size measurements in binary Al-Ti alloys suggest that particles of a nucleating phase must be present at concentrations as low as 0.01 wt % Ti, and it is suggested that these could be Al_3Ti if the existing binary phase diagram Al-Ti is in error. (auth)

19464 Nd-Rh SYSTEM. Singh, P. P.; Raman, A. (Louisiana State Univ., Baton Rouge). Met. Trans.; 1: 233-7(Jan 1970).

The phase diagram of the Nd-Rh system was determined by powder x-ray diffraction, metallographic and differential thermal analysis techniques. Eight intermediate phases occurred in the system. An Fe_3C type phase was found to be present at 19.5 at. % Rh. Nd_3Rh had a structure similar to that of La_3Rh. The other intermediate phases of the system were Nd_5Rh_3 (low and high temperature modifications), Nd_4Rh_3, $Nd_{53}Rh_{47}$ (CrB-type), $NdRh_2$ ($MgCu_2$-type), and $NdRh_3$ ($CeNi_3$-type). The phases Nd_4Rh, Nd_3Rh, Nd_4Rh_3, $NdRh_2$, and $NdRh_3$ melted congruently. Nd_5Rh_3 and NdRh were formed through peritectic reactions. The intermediate phases of the Nd-Rh system were compared with those of the La-Rh, Nd-Co, and Nd-Ni systems. Lattice vacancies are postulated to be present in the phases Nd_4Rh and NdRh. (auth)

19465 A METHOD FOR DETERMINING FRACTURE PLANES IN BERYLLIUM SHEET BY THE USE OF ETCH PITS. Hepfer, W. D.; Betner, D. R.; Herman, M.; Thevenow, V. H. (General Motors Corp., Indianapolis). ASM (Amer. Soc. Metals), Trans. Quart.; 62: 926-9(Dec 1969).

An etch pit technique was developed to determine the crystallographic orientation of grains in the fracture origin area of polycrystalline beryllium sheet. Single crystals of beryllium were used to determine the etch pit configurations on predetermined crystallographic planes. By matching the known etch pit configurations to those in the fracture origin area of the polycrystalline sheet, one can determine the orientation of the fracture planes. This technique gives crystallographic information on fracture planes of polycrystalline beryllium sheet that is not possible by conventional x-ray diffraction. (auth)

19466 MICROSTRUCTURE OF ARC-CAST TUNGSTEN AFTER HIGH-TEMPERATURE CREEP DEFORMATION. Rau, R. C.; Bartram, S. F.; Flagella, P. N. (General Electric Co., Cincinnati). Contract AT(40-1)-2847. ASM (Amer. Soc. Metals), Trans. Quart.; 62: 949-56(Dec 1969).

Microstructural studies were carried out on wrought, arc-cast, polycrystalline tungsten after creep-rupture testing at stress levels ranging from 0.21 to 5.62 kg/mm^2 at 1,600 to 3,000°C. Using optical and electron microscopy and Laue x-ray diffraction techniques, the subgrain sizes, dislocation densities, and subgrain boundary tilt angles and dislocation contents were determined and correlated

with the creep conditions. These observations showed that subgrain sizes were independent of test temperature and were inversely related to creep stress, that the density of free dislocations appeared to depend upon both temperature and stress, and that subgrain misorientations were generally small, averaging less than 0.5°. Crystallographic analysis indicated that tilt, twist, and mixed type subgrain dislocation networks were formed during creep. These networks were composed principally of dislocations having a/2⟨111⟩ Burgers vectors, with short a⟨100⟩ segments at nodal points. (auth)

19467 MICROSTRUCTURE AND HARDNESS OF IRON–MOLYBDENUM–CARBON AND IRON–TITANIUM–CARBON ALLOYS AFTER RAPID COOLING FROM THE MELT. Zboril, Josef; Posedel, Zdenka (CS-Akademie der Wissenschaften, Prague). Z. Metallk.; 61: 214-17(Mar 1970). (In German).

Sufficiently rapid cooling of liquid Fe–Mo–C and Fe–Ti–C liquid alloys led to very fine dispersions of the phases and to super saturation of the alloying elements in the matrix solid solution. Suitable annealing treatments may lead to the formation of a finely dispersed secondary precipitate. Since the liquid solubility at high temperature was practically unlimited, a sufficiently high cooling rate permitted the volume fraction of the dispersed phase to be increased arbitrarily and the particle size and spacing adjusted independently. The particle shape and the chemical stability in relation to that of the matrix can be changed by a suitable choice of the system. (auth)

Radiation Effects

Refer also to abstract 19966.

19468 (LA–4387) EFFECTS OF NEUTRON RADIATION (OR RADIATION DAMAGE) ON NIOBIUM AND NIOBIUM ALLOYS: A BIBLIOGRAPHY. Furnish, Jean (comp.) (Los Alamos Scientific Lab., N. Mex.). 18 Mar 1970. Contract W-7405-eng-36. 14p. Dep. CFSTI.

Nuclear Science Abstracts, v.22-23 (1968–69), was searched for information on effects of neutron radiation (or radiation damage) on niobium and its alloys. Entries are arranged in the order they appeared in Nuclear Science Abstracts. (auth)

19469 (NRL–7006) CHARPY-V NOTCH DUCTILITY CHARACTERISTICS OF NEUTRON-IRRADIATED A537-B AND A350-LF2 STEEL WELDMENTS. Gray, Robert A. Jr. (Naval Research Lab., Washington, D. C.). 15 Oct 1969. Contract AT(49-5)-2110. 16p. Dep. CFSTI.

The nuclear service performance of thin (¾-inch) structural steel plate irradiated at 150°F to a fluence of 2.5×10^{18} neutrons/cm^2 of energies greater than 1 MeV has been examined and documented with experimental results. Five ¾-inch A537-B steel plates, an A350-LF2 forging, and weldments of both types of steel provided the specimen stock for the irradiation assessments. The two steels responded to low-temperature irradiation in a manner similar to a well-documented A212-B pressure vessel steel. However, both A537-B and A350-LF2 steels have an inherently greater tolerance to the effects of irradiation damage by virtue of their lower initial transition temperature. Embrittlement due to irradiation produced increases in transition temperature, but for no component of the weldments studied was the 30-ft-lb value greater than 65°F. The postirradiation assessments of the Charpy-V notch shelf energy values of A537-B plate in the ASTM WR orientation (weak direction) revealed a marked reduction in the steel's fracture resistance at maximum (shelf-level) ductility. This is believed to be due to the high cross-rolling ratio and points up the need to maintain ratios near unity to ensure WR notch ductility properties approximating those for the RW (strong) direction. (auth)

19470 (NRL–7011) TRENDS IN CHARPY-V SHELF ENERGY DEGRADATION AND YIELD STRENGTH INCREASE OF NEUTRON-EMBRITTLED PRESSURE VESSEL STEELS. Hawthorne, J. Russell (Naval Research Lab., Washington, D. C.). 21 Oct 1969. Contract AT(49-5)-2110. 28p. Dep. CFSTI.

The effects of neutron irradiation on Charpy-V shelf energy and yield strength have been examined for three pressure vessel steel compositions: A302-B, A533, and A543. The effects of radiation exposure at 149°C and at 288°C to 393°C on the overall notch ductility are documented and compared. Summary plots showing the simultaneous degradation in shelf energy and the increase of yield strength levels broadly illustrate the progressive change from ductile fracture performance to relatively brittle characteristics. The data for all three steel types suggest a common pattern of properties behavior. A three-stage change of shelf level versus yield strength is indicated with progressive neutron exposure at 149°C. Data patterns for strong (longitudinal) versus weak (transverse) test orientations of thick section plate imply strong trend similarities. Properties modified by progressive radiation exposure at 288°C are interpreted as following the same damage path described by 149°C irradiation. The much slower pace of property changes with elevated temperature exposure is readily identified by trend line presentations. Observations show that A533 plate and weld metals (Grades B and C, Classes 1 and 2) have greater toughness retention than the ASTM A302-B reference heat (6-in. plate) after 288°C radiation. Results for a single reference heat of A543 Class 1, 8-in. plate demonstrate that a lower initial brittle/ductile transition temperature in itself may not fully eliminate the general problem of providing sufficient notch ductility to allow for radiation embrittlement in service. Studies of A543 steel also reveal that temper embrittlement introduced during fabrication is not a strong influence on subsequent irradiation-induced changes in Charpy-V notch ductility at exposure temperatures up to 399°C. (auth)

19471 (ORNL–4512, pp 70-93) INVESTIGATIONS OF IRRADIATED MATERIALS. (Oak Ridge National Lab., Tenn.).

Results of investigations concerning radiation effects on thick-section pressure vessel steel are presented. Information is included on effects of specimen size, radiation effects on fracture in heavy-section specimens, weldment properties, embrittlement, and strain aging. (J.R.D.)

19472 BOUNDARY MIGRATION IN NEUTRON-IRRADIATED COPPER BICRYSTALS. Haessner, F.; Holzer, H. P. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Scr. Met.; 4: 161-5(Mar 1970).

High-angle boundaries of strain-free grains can move into a deformed matrix at sufficiently high temperatures. The driving force for this process is provided by the free energy stored in the material during deformation. The elementary process for the motion of grain boundaries most likely consists in the uncorrelated jumps of single atoms from one lattice into the boundary region and then into the lattice of the other grain. The atoms diffuse in the boundary region until they find vacant lattice sites in the adjacent grains. From theoretical considerations, the boundary velocity is expected to increase with increasing porosity in the boundary region (vacancy content) and also with increasing number of point defects in the matrix lattice. A number of experimental observations confirm this expectation, at least qualitatively. The present work was undertaken to investigate more exactly the influence of point defects or point defect agglomerates on the motion of grain boundaries. (auth)

19473 NEW ALLOY STEELS FOR NUCLEAR REACTOR PRESSURE VESSELS AND VESSEL INTERNALS. Grounes, M.; Rao, S. (Aktiebolaget Atomenergi, Studsvik, Sweden). ASM (Amer. Soc. Metals), Trans. Quart.; 62: 902-14(Dec 1969).

Future nuclear power reactors will require very large steel pressure vessels. There will be incentives to decrease the weight and plate thickness of both the vessels and vessel internals by increasing the steel's strength and to use steels with good resistance to fracture and to corrosion. These requirements led to several investigations of two alloy steels, Avesta 248SV (16 Cr, 5 Ni, 1 Mo) which is ferritic-martensitic-austenitic and Bofors 2RMO (13 Cr, 6 Ni, 1.5 Mo) which is martensitic-austenitic. The metallography of the steels is described and a review of their strength, impact, and fatigue properties is given. The tensile strengths were above 70 kg per mm^2 (100,000 psi) at 300°C. The steels showed remarkable ductility even at temperatures down to –196°C. The impact energy-vs-temperature curves were smooth and exhibited no prominent transition. Crack-propagation tests gave very low transition temperatures, below –190°C. The incentives for a fracture-mechanics testing program are described, and some preliminary results obtained with COD tests are given. The calculated fracture toughness (K_c) values at –196°C, as obtained from slow bend tests, were about 115×10^6 Nm$^{-\frac{3}{2}}$. The physical properties are reviewed; the thermal expansion was equal to that of ferritic steels and the thermal conductivity was slightly higher than for 18-8 type steels. A summary of irradiation-effects data obtained after about 10^{17} – 10^{20} n/cm^2 (>1 MeV) at 60 to 350°C is given. Tests on materials from recent heats, irradiated at about 310°C to 4×10^{19} n/cm^2 (>1 MeV), showed an unusual irradiation-induced increase in ductility or a small decrease and a very low post-irradiation transition temperature. The steels might be welded without preheating in some cases. Big castings can be obtained. (auth)

19474 DEPENDENCE OF THE PULVERIZATION OF A TARGET ON THE IMPACT ANGLE OF THE BOMBARDING PARTICLES. Firsov, O. B. Dokl. Akad. Nauk SSSR; 189: 302-4(11 Nov 1969). (In Russian).

In pulverization of a solid bombarded with several kilovolt-energy particles, collision of the particles with the atoms of the medium plays an important role at the effective surface layer.

The effective depth of this action was examined to determine the conditions at which the pulverization coefficient reaches its maximum. An approximation was derived to estimating this effective depth, applying the formula to data reported in the literature. The depth is given in units of $N^{-\frac{1}{3}}$, where N is the number of atoms per unit volume of the medium. The metals used in the calculation were Cu, Mo, Ag, Fe, and Ni in nitrogen and inert gases. (TTT)

19475 INFLUENCE OF BOMBARDMENT BY β PARTICLES ON THE EVAPORATION OF SILVER FROM ALUMINUM–SILVER ALLOYS. Malinin, G. F.; Priselkov, Yu. A.; Klimenko, G. G.; Spitsyn, V. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 188: 846-8(1 Oct 1969). (In Russian).

The effect of β radiation from ^{90}Sr and ^{90}Y on the evaporation of silver from its alloy with about 5 at. % aluminum was investigated by means of a pressure measuring device based on the effusion method. The radioactive strontium oxide with an activity of 6 μCi was deposited on the interval surface of the ceramic lid of the effusion chamber. A vacuum of 1 to 3×10^{-6} torr was maintained within the system. It was found that because of the small contribution of the radiation to the overall energy balance, it did affect, only very slightly, the equilibrium parameters of the flow rate and vapor pressure. The observed, β-irradiation-induced increase of the evaporation rate is probably due to the increase of the transport rate of silver atoms through the surface layer as a result of various aftereffects of the radiation, such as the creation of a surface charge, defects, etc. (TTT)

19476 INFLUENCE OF NEUTRON IRRADIATION ON THE GRAIN GROWTH OF URANIUM DURING SUBSEQUENT ANNEALING. Dmitriev, V. D.; Ibragimov, Sh. Sh. Dokl. Akad. Nauk SSSR; 189: 305-6(11 Nov 1969). (In Russian).

The recrystallization of deformed uranium was studied to establish the effect of previous irradiation. The natural, technical-grade, 99.81% pure uranium specimens were rolled at 500°C and annealed at 590°C, exposing the rods at 100 to 150°C to a neutron flux until a 0.01 at. % burning which corresponded to 2.7×10^{19} n/cm^2. As a result of the irradiation, the length of the rods increased by about 4.5% and the hardness increased from 250 to 260 to 290 to 300 kg/mm^2. Sections cut from the rods were then annealed in a salt bath at temperatures ranging from 200 to 700°C for periods from 1 to 16 and more hours. The polished and etched specimens revealed that annealing for 1 hour at temperatures of 160°C changed the microstructure of the irradiated or unirradiated specimens. The hardness of irradiated uranium was regenerated at temperatures below 450°C. Soaking at 660°C, at the α-phase region for 100 hours resulted in strong grain growth of the unirradiated uranium; the grains size of the indicated specimens must be held at that temperature for more than 600 hours. The effects are due to the formation of points defects, creation of hot spots, microstructural changes and the building of fission products. (TTT)

Ceramics and Cermets

Refer also to abstracts 19380 and 19428.

Corrosion and Erosion

Refer also to abstract 19393.

19477 (KFK–1086) COMPARISON OF LONG AND SHORT COMPATIBILITY TESTS ON UN AND UO_2. Goetzmann, O.; Hein, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Nov 1969. 10p. (In German). Dep. CFSTI (U. S. Sales Only).

Compatibility tests were performed on the cladding materials vanadium, VTi5Nb2O, VTi1O, VTi2O, stainless steel (XCrNiTi 18/9), Incoloy 800 (Nicrofer), Incoloy 625 and Inconel 718 with nuclear fuels UN and UO_2. The test temperatures were at 760 and 800°C, and the annealing time was 1000 hr. The behavior of the different compatibility couples is described and compared with the results of former, more systematic compatibility tests where the annealing times were a maximum of 144 hr. The conclusions drawn from those short-time-test results for the compatibility behavior of the different systems could be supported by these investigations fairly well. Only the results of Incoloy 800 (Nicrofer) with UN as well as UO_2 differed from those that were expected. (auth)

19478 STUDIES OF CHEMICAL STABILITY OF HAFNIUM DIBORIDES. Savitskii, E. M.; Timofeeva, N. I.; Bakarinova, V. I. (Inst. of Metallurgy, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 120-1(Jan 1970). (In Russian).

Chemical stability of HfB_2 in various chemical reagents at room temperature and HfB_2 corrosion resistance at 700 to 1100°C were investigated using hafnium diboride powder 89.2 wt % Hf, 11.3 wt % B, and 0.1 wt % C. It was found that HfB_2 partially dissolved after 24 hr in concentrated HCl, H_2SO_4, and $HClO_4$, at room temperature. Specimens of powder compressed at 2200°C for 3 to 5 min and tested in the air at 700, 800, 1000, 1100°C, showed that oxidation begins at 700°C. The oxidation of specimens in oxygen tested at 20 to 1100°C showed the rate of oxidation varies according to parabolic low. (At temperatures from 700 to 1200°K the activation energy is 20,400 cal and at 1200 to 1400°K it is 34,900 cal.) (R.V.J.)

19479 INTERACTION OF ATOMIC HYDROGEN AND NITROGEN WITH GRAPHITE SURFACE. McCarroll, B.; McKee, D. W. (General Electric Co., Schenectady, N. Y.). Nature (London); 225: 722-3(21 Feb 1970).

It was found by Marsh et al. (Trans. Faraday Soc., 58: 285(1965)) that atomic oxygen reacts with graphite to cause pitting uncharacterized by any particular symmetry. In direct contrast to this behavior it was observed that regular hexagonal pits were formed on the cleavage surfaces of graphite crystals on exposure to atomic hydrogen or atomic nitrogen. Carefully cleaved crystals of Ticonderoga graphite were employed for the experimental work described. The flowing gases were dissociated with a microwave discharge, and during the experiment the gas flow rate, sample temperature and power input to the discharge tube were maintained constant. Exposure of a sample to flowing molecular hydrogen at 720°C for 8 hours produced no observable changes in the surface structure of the graphite crystals, but in the presence of the discharge well defined features appeared rapidly on the graphite basal plane exposed to the dissociated gas, including hexagonal etch pits all perpendicular to the $\{11\bar{2}0\}$ trim bands, with the sides of the pits consisting of $\{10\bar{1}\,1\}$ prismatic faces. As with molecular oxygen above 1000°C the atomic hydrogen reacted preferentially at the cores of the nonbasal dislocations threading the graphite crystals. Other features produced by atomic hydrogen included terraced pits, pits within pits, and pits on twist boundaries comprised of c-axis screw dislocations. With regard to flowing nitrogen no detectable surface changes were produced by an 8 hr exposure at 1,100°C in the absence of the discharge. With the discharge, however, hexagonal pits were formed in many regions of the graphite basal plane at this temperature. These pits developed parallel orientation and the preferred directions of attack in the 2-plane were along the $\langle 1010 \rangle$ directions. The etching behavior was identical with that observed with molecular oxygen below 800°C. The development of macroscopic pits implies that there are significant inequalities in the chemical reactivity of the microscopically imperfect graphite surface. The observed differences in the effects produced by atomic oxygen and atomic hydrogen may be related to the differences in surface mobilities of these absorbed species. The behavior for nitrogen atoms suggests that a mobile layer is involved during the attack. (UK)

19480 A CONTRIBUTION TO ENDEAVOURS AIMED AT ESTABLISHING A NEW SUITABLE METHOD TO EVALUATE THE RESISTANCE TO WEAR FOR SINTERED CARBIDES. Carboni, E. (Metalloceramica Vanzetti, Milan). Met. Ital.; 61: 593-601(Dec 1969). (In Italian).

There is a general lack of experimental data on resistance to wear for chill castings of white cast iron, for hard chromium tips, and for alloys based on carbides. Information is presented on sintered carbides and relations as far as resistance to abrasion is concerned, existing between sintered carbides and various types of steel. Fabricators and planners may take advantage of this study to get their choice, as regards the best materials to withstand the wear by abrasion. (auth)

Preparation and Fabrication

Refer also to abstracts 19049 and 19052.

19481 (ARH–1153) CERAMIC PROPERTIES OF PuO_2. Rasmussen, O. R. H. (Atlantic Richfield Hanford Co., Richland, Wash.). 25 Mar 1969. 37p. Dep. CFSTI.

Results of a literature survey are presented. Reported research shows that plutonium dioxide made via the plutonium-IV oxalate precipitation and calcination process appears to be a highly sinterable powder. If sufficiently pure plutonium nitrate is used, a direct calcination process may yield a PuO_2 powder with suitable sintering characteristics. A calcination temperature of 750°C yields the most suitable oxide powder obtainable from plutonium oxalate for blending with UO_2 in the production of UO_2–PuO_2 fuel pellets. The most efficient method of blending large quantities of UO_2 and PuO_2 powders appears to be V-blending followed by dry ball milling or hammermilling. For blending of small quantities

of mixed oxides, wet ball milling has been found effective. The addition of excessive organic binder to PuO_2 powders results in lowered densities of the sintered pellets. The final sintered density for PuO_2 has been found to be relatively insensitive to pressing pressures in the range of 10 to 40 TSI when sintering in a reducing atmosphere. Sintering PuO_2 in an oxidizing atmosphere such as air yields higher densities than sintering in a reducing or inert atmosphere. When PuO_2 is sintered in a reducing atmosphere such as Ar–6% H_2, a sintering temperature of 1400 to 1500°C yields maximum densities. In air, sintered density increases slightly above 1500°C, and 1600°C has been found to be a practical temperature limit. (J.R.D.)

19482 (BNWL-1212) 1968-1969 USAEC/AECL COOPERATIVE PROGRAM ON U_3Si COEXTRUSION DEVELOPMENT AND BILLET PREPARATION. Ard, P. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1970. Contract AT(45-1)-1830. 80p. Dep. CFSTI.

Programs on U_3Si coextrusion and U_3Si billet preparation are described. Efforts to develop technology for coextrusion of zirconium alloy clad fuel rod stock with small central axial holes to accommodate radiation induced swelling, and to develop alternate methods for producing case uranium silicon alloy billets with a fine uranium and U_3Si_2 microstructure necessary for reducing the deltizing heat treatment time are summarized. Several 0.600-in. OD coextrusions with small 0.200-in. dia central coaxial holes were produced from 2¼-in. billets containing castings of uranium silicon alloys with compositions of U–3.6 wt% Si to U–4.15 wt% Si. The U_3Si material was successfully coextruded with both Zr–2 and Zr–2.5Nb cladding materials. Several 3-in. dia coextrusion billets were extruded at reductions of from 15.7/1 to 21/1, and at extrusion ram speeds of 40, 60, and 120 in./min. The billets were produced from cast U–3.8 wt% Si using both Zr–2 and Zr–2.5Nb for cladding material. These billets were all successfully extruded with a 0.250-in. dia coaxial void except for the billet extruded at the slower 40 in./min speed in which the mandrel overheated and failed. Several billet end designs were tested on the 3-in. dia billets in an effort to reduce the breaking which occurs near both ends of extrusions from both the 2¼-in. and 3-in. billets. Two lead end designs proved successful in preventing this breaking, but attempts at tail end designs were not satisfactory. Small defects in the U_3Si core immediately under the cladding U_3Si interface were prevalent in most of the 3-in. billet extrusions. These defects are thought to be caused by billet chilling against the relatively cold tooling and small inclusions within the U_3Si cores. Attempts to produce a finer uranium and U_3Si_2 microstructure in uranium silicon alloy billets by vacuum consumable electrode melting were not successful. However, a very fine microstructure was produced in the cast uranium silicon alloy shot made by the spinning disk method. (auth)

19483 (CEA-CONF-1427) CONTROL OF THE HOMOGENEITY OF SHIELDING. Vertut, Jean; Papot, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [nd]. 8p. (In French). (CONF-691008-16; SM-125/53). Dep. CFSTI (U. S. Sales Only).

From Symposium on Radiation Safety Problems in the Design and Operation of "Hot" Facilities, Saclay, France.

Control of cast concrete shielding homogeneity is evaluated as related to defects. The types of defects, specific defects in transfer and transport containers, and the specific defects of shielded enclosures are discussed. The criteria given by the AIEA for the acceptance of shield defects are given and critically analyzed. (J.S.R.)

19484 (ORNL-4365, pp 9-20) SOL-GEL DEVELOPMENT STUDIES. (Oak Ridge National Lab., Tenn.).

The development of sol-gel processes for use in preparing ceramic nuclear fuels, particularly small UO_2 microspheres, was continued. UO_2 sols were prepared in batch precipitation-filtration-peptization equipment using a flowsheet featuring precipitation at pH 7.3. The development of equipment to allow UO_2 sols to be prepared by precipitation-washing-peptization, using a continuous type of operation, was terminated and summarized. More than 10 liters of UO_2–C sol was formed into microspheres, using 2-ethyl-1-hexanol (2EH) temperatures of about 30 and 45°C to improve the operation. The method for preparing UO_2 spheres smaller than 100 μ in diameter was improved by using a new sol-dispersion procedure and by using isoamyl alcohol in place of 2EH. (auth)

19485 COMPOSITE ALUMINIUM ALLOYS MADE FROM THIN SHEET: A FEASIBILITY STUDY. Beghi, G. (EURATOM-CCR, Ispra, Italy); Kellerer, H. Int. J. Powder Met.; 6: 45-58 (Jan 1970).

Composite materials may be fabricated by thin-sheet metallurgy, the technique which is based on the utilization of metals as thin sheets. Information is given on the possible fabrication schedules principally with regard of the methods of introducing the second phase. The potential and the advantages of sheet-metallurgy are pointed out and examples are given for Al–$NbAl_3$, Al–Al_2O_3, and Al–Al_2O_3–MgO alloys. Preliminary experiment results also indicated the possibility of producing fiber reinforced aluminum by the sheet method. (auth)

19486 CONCRETE WORKS IN THE TSURUGA ATOMIC POWER STATION OF JAPAN ATOMIC POWER COMPANY. Fujino, Tsuneo; Kushida, Toshimi (Takenaka Komuten Co., Tokyo). Konkurito Janaru; 7: No. 9, 21-31(Sep 1969). (In Japanese).

The civil engineering services, including concrete construction, were performed by Takenaka Komuten as a subcontractor. The concrete works by Takenaka Komuten, including the buildings for the reactor, turbogenerator, and waste disposal, are described. Operation and maintenance are described and outlines of the Tsuruga atomic power station including the specifications by Ebasco for services, materials (cement, aggregate, and additives), and concrete (installation of the concrete plant, preparation of the concrete and its pouring, quality control of the concrete) are included. (NSA of Japan)

19487 NEW TANTALUM NITRIDES. DOUBLE NITRIDE AND OXINITRIDES OF TANTALUM AND NIOBIUM. Fontbonne, A.; Gilles, J.-C. (CECM, Vitry-sur-Seine, France). Rev. Int. Hautes Temp. Refract.; 6: 181-91(Jul-Sep 1969). (In French).

The disintegration of Ta_3N_5 in argon and Ta_2O_5 in ammonia atmosphere leads to two new tantalum nitrides (Ta_4N_5 and Ta_5N_6), the structures of which are determined. These can be described as pseudo-cubic or hexagonal close-stacked tantalum atoms with ordered vacancies. The chemical action of ammonia on double oxides of niobium and tantalum was also studied. Double nitrides or oxinitrides are obtained; their structures come from the structures of simple nitrides of tantalum and niobium. (auth)

19488 REACTIVE HOT PRESSING OF NONSTOICHIOMETRIC URANIUM DIOXIDE. Warren, I. H.; Chaklader, A. C. D. (Univ. of British Columbia, Vancouver). Met. Trans.; 1: 199-205(Jan 1970).

High density UO_{2+x} pellets were produced by reactive hot pressing uranyl oxalate at temperatures up to 700°C. Rapid densification occurred during the decomposition reactions resulting in densities in the range 90 to 92% of the theoretical. A density of 98% of the theoretical value was achieved by further hot-pressing at 650 to 700°C for 30 min. This densification behavior can be related to the nonstoichiometry and submicron sized particles of UO_{2+x} produced in the decomposition reactions. The kinetics of hot-pressing of powder compacts of this UO_{2+x} were studied in the temperature range 500 to 700°C. The results were analyzed utilizing models proposed by Fryer. The activation energy of 53 kcal per mole, obtained from this analysis is the same as that for creep of nonstoichiometric urania in the temperature range 975 to 1400°C, suggesting that the mechanism controlling the rate of the final stage of densification may be a creep process. (auth)

19489 HYDROGEN REDUCTION OF MoO_3 AT TEMPERATURES BETWEEN 300° AND 450°C. Hawkins, Donald T.; Worrell, Wayne L. (Univ. of California, Berkeley). Met. Trans.; 1: 271-3(Jan 1970).

Molybdenum trioxide (MoO_3) was reduced by hydrogen at temperatures between 300 and 450°C. The weight lost during each reduction experiment was followed using an automatic recording balance. X-ray diffraction analysis of the reduction product and the weight-loss data confirmed the formation of a suboxide of molybdenum having a composition between Mo_2O and MoO. (auth)

19490 PREPARATION OF U_4O_9 SINGLE CRYSTAL. Masaki, N. (Japan Atomic Energy Research Inst., Tokai); Ishii, T. J. Cryst. Growth; 6: 207-9(Jan-Feb 1970).

A simple method for preparing U_4O_9 single crystal from UO_2 single crystal, UO_2 powders, and U_3O_8 powders by solid state diffusion of oxygen obtained by thermal dissociation of U_3O_8 powders is described. Identification was carried out by x-ray and neutron diffraction. (auth)

Properties Evaluations

Refer also to abstracts 19404, 19405, 19409, 19410, 19422, 19439, 19444, 19445, 19447, 19481, 19511, 19978, and 19982.

19491 (CONF-691002–, pp 366-92) THERMAL DIFFUSIVITY OF ATJ-S GRAPHITE FROM 100° TO 3000°K. Morrison, B. H. (Los Alamos Scientific Lab., N. Mex.).

The thermal diffusivity of a molded graphite, ATJ-S, was measured in the with-grain and across-grain directions from 100 to 3000°K by the laser flash technique. A neodymium glass laser system supplied the thermal energy pulse; thermocouples or a photomultiplier tube detected the transient time-temperature response of thin samples. The thermal diffusivity values, corrected for heat losses and finite pulse time, were fitted to an equation in reciprocal temperature by a least squares technique. Repeated measurements on duplicate samples demonstrated a precision of ±4%. Accuracy was estimated at ±7% by comparison with published thermal diffusivity measurements on Armco iron. (auth)

19492 (CONF-691002–, pp 393-419) THE THERMAL CONDUCTIVITY OF PYRO-CARB 406: A CARBON–CARBON COMPOSITE. Brazel, J. P.; Dubin, P.; Kennedy, B. S. (General Electric Co., Philadelphia, Pa. Re-entry and Environmental Systems Div.).

A series of measurements to determine the density and microstructure dependent anisotropic thermal conductivity of Pyro-Carb 406 carbon–carbon composite is described. Initial characterization by comparator measurements on flat plates established the thermal conductivity levels and the degree of anisotropy at temperatures from 300 to 600°K. A transient thermal conductivity technique was then applied to determination of the across-lamina conductivity at temperatures up to 2200°K. The computer-coded data analysis of this technique also yielded the intrinsic density dependence of the conductivity for actual heatshield hardware–a critical aspect for the material's successful application. The with-lamina (fill and warp direction) thermal conductivity was found to be an even more sensitive function of the varying microstructure through the Pyro-Carb wall thickness. To resolve this small scale variation of the with-lamina conductivity, a miniature cut-bar comparator was designed and constructed to take a $\frac{3}{16}$-inch diameter sample. These measurements to 900°K were then complemented by the transient techniques which were used for measurements to 1900°K. An anisotropy of 3:2:1 was shown for Pyro-Carb 406 Warp: Fill: Across-Lamina thermal conductivity, with a moderate positive slope in the temperature dependence. The high density pyrolytic surface case material was found to have a processing-sensitive 1/T temperature dependence. (auth)

19493 (CONF-691002–, pp 421-47) THE EFFECTIVE THERMAL CONDUCTIVITY OF PYROLYTIC GRAPHITE CYLINDERS IN VARIOUS GAS ENVIRONMENTS. Pyron, C. M. Jr.; Smyly, E. D. (Southern Research Inst., Birmingham, Ala.).

The effective thermal conductivity of thin wall pyrolytic graphite (PG) cylinders was determined experimentally in vacuum, nitrogen, and helium environments at temperatures from 800 to 2500°K. Several techniques of measuring temperature gradients in the cylinders were explored and the errors associated with some of the classical methods using contact thermocouples were determined. The data were correlated with analytical expressions based on a mathematical model of the delaminated cylinder. These expressions were used to predict the effective conductivity at temperatures outside the range covered by the measurements and in other environments. It was shown that above 1370°K the effective conductivity of cylinders in a helium or hydrogen environment is about 80 to 90% of the conductivity of undelaminated PG plates. In vacuum, the effective conductivity of cylinders is only about 10 to 20% of the conductivity of plates at 800°K, but increases to about 70% of the plate value at 3000°K as radiant transport across the delaminations becomes more significant. (auth)

19494 (COO-716-55) VAPOR PRESSURE MEASUREMENTS IN THE SmC_2–C AND TmC_2–C SYSTEMS. Seiver, Robert L.; Eick, Harry A. (Michigan State Univ., East Lansing). [1969]. 12p. (CONF-700403–2). Dep. CFSTI.

For Presentation at 8th Rare Earth Conference, Reno, Nev.

Samarium and thulium dicarbides have been prepared by direct reaction of the elements in sealed tantalum bombs and an extensive study of their vaporization behavior has been completed. Container interaction which was observed was demonstrated to have negligible effect on the measured decomposition pressures. The cause of the large discrepancies in previous reports of the SmC_2 decomposition pressure was found to be oxygen contamination; most workers inadvertently have been studying the reaction: $Sm_2O_3(s) + 3\ C(s) \rightarrow 2\ Sm(g) + 3\ CO(g)$ (1). The oxide probably resulted from hydrolysis by atmospheric water vapor. Samples in this laboratory were observed to hydrolyze significantly even in a P_2O_5 charged glove-box. Handling procedures necessary to prevent this hydrolysis are discussed. The correct value of the decomposition pressure of samarium in equilibrium with $SmC_2(s)$ is $\ln P_{Sm(atm)} = [(-32{,}7_{40} \pm 4_{60})/T] + (8.8_4 \pm 0.2_5)$ and that of thulium in equilibrium with $TmC_2(s)$ is $\ln P_{Tm(atm)} = [(-35{,}5_{70} \pm 3_{40})/T] + (8.9_9 \pm 0.1_9)$. Results of second- and third-law data reductions are reported, and ΔH°_{298} is $18._4 \pm 1._3$ kcal/gfw for $SmC_2(s)$ and, $20._9 \pm 2._0$ kcal/gfw for $TmC_2(s)$. The data extend the correlation between enthalpy of vaporization of the lanthanide dicarbides and vapor pressure of the pure metal. (auth)

19495 (GEAP-12032) A THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 8, May 1–August 1, 1969. Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Sep 1969. Contract AT(04-3)-189. 7p. Dep. CFSTI.

Progress is reported on scope of work related to measurement of liquidus-solidus transformations, vaporization of urania, and oxygen redistribution in a temperature gradient. In addition, the scope of new experiments in progress to study interactions in the sodium-uranium-plutonia system is presented. (auth)

19496 (GEAP-12047) A THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 9, August–November 1969. Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Jan 1970. Contract AT(04-3)-189. 8p. Dep. CFSTI.

Progress is reported on the continuing work related to vaporization of urania, oxygen redistribution in a temperature gradient, and sodium fuel interaction. In addition, the scope of follow-on experiments to study mechanistic aspects of oxygen redistribution in a temperature is presented. (auth)

19497 (KFK-1112) PREPARATION AND PROPERTIES OF CERMETS WITH IDEALIZED STRUCTURE IN THE SYSTEM UO_2/Cr. Weimar, P.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Dec 1969. 21p. (In German). Dep. CFSTI (U. S. Sales Only).

The fabrication and some properties of UO_2-Cr cermets with idealized structure and metal content of 6 to 30 vol % are discussed. The results are compared with those for UO_2-Mo cermets. The reasons for the appearance of a disturbed microstructure specially at small metal contents, for a smaller thermal conductivity and for a low strength for UO_2-Cr cermets are discussed. The minimum in bend–strength observed for cermets with high UO_2-investment is described. Future experiments are sketched. The first irradiation results of those cermets with idealized structure are to be published separately. (auth)

19498 (UNC–5251) FAST REACTOR MIXED-CARBIDE FUEL ELEMENT DEVELOPMENT PROGRAM. Ninth Quarterly Progress Report, July–September 1969. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center). 1 Dec 1969. Contract AT(30-1)-3415. 44p. Dep. CFSTI.

Three fuel rods containing helium-bonded, high-density mixed-carbide pellets were discharged from the EBR-II with a peak burnup of 57,000 Mwd/t. The first all mixed-carbide subassembly ever to be irradiated has accumulated ~51,000 Mwd/t in the EBR-II. The experiment designed to measure the fission gas released by various mixed-carbide fuel compositions at temperatures up to 1600°C has achieved its goal burnup of 20,000 Mwd/t and was discharged from the DUN irradiation testing facility. Three of the four experiments containing sodium-bonded, mixed-carbide pellet fuel rods were discharged from the GETR after achieving their goal burnup of 50,000 Mwd/t. Thirty-two hundred and seventy-five UO_2-25 wt % PuO_2 pellets for the Westinghouse irradiation program were prepared to specification and shipped to WARD. (auth)

19499 HIGH-TEMPERATURE THERMODYNAMICS OF URANIUM CARBIDES. II. CALCULATIONS OF U AND C ACTIVITY BASED ON STORMS DATA. Nikol'skii, S. S.; Levina, I. N. Teplofiz. Vys. Temp.; 7: 1087-94(Nov-Dec 1969). (In Russian).

Relations were obtained for the U vapor pressure, carbon activity, temperature, and composition of solid UC_γ solution. The equations are in good agreement with experimental $\lg p_U$ as functions of temperature and composition. Calculations were made of $\lg p_U$ and $\lg a_C$ and free energy of reaction $xU(g) + (1 - x)C$ (graphite) $\rightarrow U_xC_{1-x}{}_{solid}$ at C/U = 0.90 and 0.95 to 1.90 and T = 1600 and 1700 to 2800°K. The metastable and unstable state regions were found in relation to the solid solution disentegration into UC and UC_2. Calculations were made of carbon activity in carbide equilibrium with liquid uranium, of the vapor composition, the rate of evaporation of components, and of the conditions of congruent evaporation. (R.V.J.)

19500 MASS SPECTROMETRIC STUDY OF THE VOLATILIZATION BEHAVIOR IN THE PLUTONIUM–CARBON SYSTEM.

Battles, J. E.; Shinn, W. A.; Blackburn, P. E.; Edwards, R. K. (Argonne National Lab., Ill.). High Temp. Sci.; 2: 80-93(Mar 1970).

The volatilization behavior of the univariant solid systems Pu_2C_2 + C, PuC_2 + C, and Pu_2C_3 + PuC_2 has been investigated by combined mass-loss and mass spectrometric Knudsen effusion studies. The vapor phase in equilibrium with each univariant system is the same, primarily Pu(g) with only a minor amount (<0.1 %) of PuC_2(g) observed over the solid system PuC_2 + C. Mass spectrometric data are combined with the mass-loss effusion data to yield the following equations for the vapor pressure. For the reaction $\frac{1}{2}Pu_2C_3(s) \rightleftharpoons Pu(g) + \frac{3}{2}C(s)$, log P(atm) = (4.510 ± 0.140) − [(21,330 ± 240)/T] (1579 − 1933°K) with ΔH^0_T = 97.59 ± 1.08 kcal/mol Pu(g). For the reaction $2Pu_2C_3(s) \rightleftharpoons Pu(g) + 3PuC_2(s)$, log P(atm) = (6.910 ± 0.140) − [(25,940 ± 240)/T] (1933 − 2299°K), with ΔH^0_T = 118.72 ± 1.10 kcal/mole Pu(g). For the reaction $PuC_2(s) \rightleftharpoons Pu(g) + 2C(s)$, log P(atm) = (3.450 ± 0.090) − [(19,290 ± 120)/T] (1933 − 2348°K), with ΔH^0_T = 88.29 ± 0.55 kcal/mol Pu(g). The enthalpy and entropy of formation of $PuC_{1.5}$(s) from the elements were evaluated at the reference temperature 298°K by combining vapor pressure data with $H^0_T - H^0_{298}$ data. The values are $\Delta H^0_{f,298}$ = −16.14 ± 1.10 kcal/mol and $\Delta S^0_{f,298}$ = +5.09 ± 0.60 eu. (auth)

19501 INVESTIGATION ON CATHODE MATERIALS PREPARED FROM MIXED METAL HEXABORIDES. Bliznakov, G.; Tsolovski, I.; Peshev, P. (Inst. of General and Inorganic Chemistry, Sofia). Rev. Int. Hautes Temp. Refract.; 6: 159-64(Jul-Sep 1969).

The formation of solid solutions in the SrB_6–LaB_6 and BaB_6–LaB_6 systems during borothermic reduction in vacuum of mixtures of lanthanum oxide, alkaline earth carbonate and boron has been investigated. The thermionic characteristics of the products obtained have been determined and compared with the corresponding data concerning pure LaB_6. It has been established that a continuous row of solid solutions appears in the SrB_6–LaB_6 system, while in the BaB_6–LaB_6 system the mutual solubility is limited. It was found that at the working temperatures, products having compositions such as 40 mole % SrB_6–60 mole % LaB_6, 40 mole % BaB_6–60 mole % LaB_6, and 70 mole % LaB_6 have better thermionic properties than pure LaB_6. (J.R.D.)

19502 ABOUT SOME NEW TERNARY COMPOUNDS WITH NIOBIUM OXIDE. Tilloca, G.; Perez y Jorba, M.; Collongues, R. (CECM, Vitry-sur-Seine, France). Rev. Int. Hautes Temp. Refract.; 6: 175-80(Jul-Sep 1969). (In French).

The study of systems existing between niobium oxide Nb_2O_5 and some other oxides (MgO, Al_2O_3, Ga_2O_3, TiO_2, V_2O_5) revealed new compounds which can be linked with one of the files of niobium suboxides. The niobium suboxides form two series of compounds at least, with the general formulas: $Me_{2n}O_{5n-2}$ and $Me_{2n+1}O_{5n-2}$. The basic elements of these structures are made of a variable number of MO_6 octahedra. (auth)

19503 TEMPERATURE DEPENDENCE AND RATE OF CONGRUENT EVAPORATION OF TANTALUM CARBIDE PHASE. Nikol'skaya, T. A.; Avarbe, R. G. (State Inst. of Applied Chemistry, Moscow). Teplofiz. Vys. Temp.; 7: 1095-1100(Nov-Dec 1969). (In Russian).

Evaporation of tantalum carbide phases from open surfaces into a vacuum was studied in a wide range of temperatures and compositions. An absence of congruent evaporation was observed at 2000 to 3400°K in the homogeneous monocarbide phase region. However, inside the homogeneous region of the semicarbide phase, tantalum evaporation was congruent in character. Temperature dependence of congruent evaporation of tantalum semicarbide phases and the rate of their evaporation at 3000 to 3400°K are analyzed. (R.V.J.)

19504 KINETIC STUDY ON OXYGEN TRANSFER BETWEEN SOLID OXIDE PHASE OF ZrO_2.CaO AND LIQUID METAL PHASE OF SILVER WITH THE AID OF ELECTROMOTIVE FORCE DECAY CURVES. Goto, Kazuhiro; Someno, Mayumi; Sano, Motohiro; Nagata, Kazuhiro (Tokyo Inst. of Tech.). Met. Trans.; 1: 23-9 (Jan 1970).

An experimental method was developed to compare the rate of the metal-oxide interface reaction, $O^{2-} = O + 2e$, with the rate of oxygen transfer in liquid metal. A direct current was supplied to cause the polarization of the galvanic cell, Air : Liquid Ag–O/ZrO_2·CaO| Liquid Ag–O : Air. The electromotive force decay curves were obtained at 1100°C immediately after the supply of the current was cut off. The degree of the polarization was increased by increasing the current and its duration time and by decreasing the area of metal-oxide interface. The absolute value of the electromotive forces was affected by the direction of oxygen transfer. The depolarization was accelerated by stirring the liquid silver. The shapes of decay curves were estimated with the rate controlling step at the first order interface reaction and at the non-steady state diffusion of oxygen in liquid metal. From the shape of the measured decay curves and the stirring effect, it was concluded that the rate of the interface reaction is much more rapid than the rate of oxygen transfer in the liquid metal under the present experimental condition. (auth)

19505 DEPENDENCE BETWEEN SPECIFIC SURFACE AREA AND REDUCTION CONDITIONS OF URANIUM DIOXIDE. Juusela, J. (Technical Univ. of Helsinki, Otaniemi, Finland). Kem. Teollisuus; No. 1, 27-31(1970). (In Finnish).

Some properties of different uranium oxides are studied from the standpoint of reactor fuel production. It is found that reduction temperature has a different effect on nonstoichiometry in direct and indirect reduction; and that the effect on specific surface area differs from that on nonstoichiometry. It is concluded that it is possible to produce uranium dioxide the nonstoichiometry and specific surface area of which can be controlled. (Finland)

19506 COMMENTS ON THE DEGREE OF PERFECTION FEASIBLE IN STRESS-RECRYSTALLIZED PYROLYTIC CARBON. Roscoe, C.; Kline, D. E.; Taylor, R. E. (Pennsylvania State Univ., University Park). Carbon; 8: 95-8(Feb 1970).

Reasonably perfect graphite crystals are currently available from three principal sources: Ticonderoga mines, solution growth, and stress-recrystallization of pyrolytic carbon. Relative merits of each are briefly discussed. Particular attention is focused on the perfection of stress-crystallized material in which the stress was produced by an external hydraulic ram and by a differential expansion technique. The latter method in particular appears promising for the production of relatively large single crystals displaying a high degree of structural perfection. (auth) (UK)

19507 MASS SPECTROMETRIC STUDIES OF PLUTONIUM COMPOUNDS AT HIGH TEMPERATURES. IV. THE VAPORIZATION OF PuN. Kent, R. A.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). High Temp. Sci.; 1: 176-83(Jul 1969).

A mass spectrometric-Knudsen effusion study has shown that in the range 1658 to 1976°K, plutonium mononitride vaporizes congruently to the elements according to the reaction $PuN_{0.96}(s) = Pu(g) + 0.49\ N_2(g)$. The plutonium partial pressure is given by log P_{Pu} (atm) = (6.445 ± 0.055) − (21,958 ± 98)/T°K. The standard heat and entropy of formation for PuN are calculated to be $\Delta H^0_{f\ 298}$ = −71.2 ± 2.5 kcal $mole^{-1}$ and $\Delta S^0_{f\ 298}$ = 19.9 ± 2.0 eu. (auth)

19508 THERMAL EXPANSION OF ERBIUM, THULIUM, AND YTTERBIUM SESQUIOXIDES. Singh, Sohan; Davenport, James C.; Mills, Norman D. J. Amer. Ceram. Soc.; 53: 169(Mar 1970).

The average coefficients of linear thermal expansion were determined for powdered cubic Er_2O_3, Tm_2O_3, and Yb_2O_3 for the temperature range of 100 to 300°K. (G.M.C.)

19509 VOIGT AND REUSS MODULI OF POLYCRYSTALLINE SOLIDS WITH MICROCRACKS. Hasselman, D. P. H. J. Amer. Ceram. Soc.; 53: 170(Mar 1970).

Data are given on the elastic moduli of theoretically dense isotropic graphite. The values of the elastic moduli, corrected and uncorrected for cracks, were compared with the Reuss and Voigt moduli. (G.M.C.)

Structure and Phase Studies

Refer also to abstract 19463.

19510 (KFK-tr-311) INVESTIGATION OF THE CARBIDE REGION OF THE SYSTEM Ta–Hf–C. Emel'yanov, V. S.; Evstyukhin, A. I.; Godin, Yu. G.; Solov'ev, G. I.; Kokhtev, S. A. Translated by Rosemarie Corssen (Kernforschungszentrum, Karlsruhe, Ger.), from Met. Metalloved. Chist. Metal., Sb. Nauch. Rabot; No. 6, 108-14(1967). 8p. (In German). Dep. CFSTI (U. S. Sales Only).

Results of phase studies of the Ta–Hf–C system are presented. Data are presented tabularly and as phase diagrams. Comment concerning the procedures used is included. (J.R.D.)

19511 INTERACTION OF CARBIDES OF TRANSITION METALS OF GROUP IV–VI OF PERIODIC SYSTEM OF ELEMENTS WITH ZIRCONIUM OXIDE. Fedorus, V. B.; Kosolapova, T. Ya.; Kuzma, Yu. B. (Inst. of Cermets and Special Alloys, Kiev). Rev. Int. Hautes Temp. Refract.; 6: 193-7(Jul-Sep 1969). (In French).

The character of interaction between some carbides of transition metals and the zirconium dioxide is studied in vacuum. Metal carbides TiC, ZrC, VC, NbC, Cr_3C_2, Mo_2C and WC are shown to interact actively with ZrO_2 in the region 1,000 to 2,000°C. The carbides of the metals of the IV groups interacting with the zirconium di-

oxide form stable oxicarbide phases such as (Ti, Zr) (C, O) and Zr (C, O), whereas products of interaction between the carbides of the metals of the V group and the zirconium dioxide are the zirconium oxicarbide and the metals of the V group (vanadium and niobium). The carbides Mo_2C and WC reduce ZrO_2 to the zirconium carbide themselves being transformed into the metals. Products of reaction between Cr_3C_2 and ZrO_2 in the region 1,000 to 1,800°C are ZrC and Cr_3C_2. The beginning temperature of interaction decreases from $Me^{IV}C-ZrO_2$ system to $Me^{V}C-ZrO_2$ and $Me^{IV}C-ZrO_2$ systems. This is explained by decreasing of thermodynamic stability of the carbides in the range $Me^{IV}C-Me^{V}C$ $Me^{VI}C$ due to peculiarity of electron structure of the metals forming these compositions. (auth)

19512 LATTICE PARAMETER AND X-RAY POWDER PATTERN OF U_2C_3. Hennecke, J. F. A.; Toussaint, C. J. (EURATOM–CCR, Ispra, Italy). J. Appl. Crystallogr.; 2: 301-3(1969).

The x-ray powder diffraction pattern and a precise determination of the lattice parameter of U_2C_3 ($a_0 = 8.0899 \pm 0.0002$ Å) are given. Results of further analysis indicate that U_2C_3 appears to be a stoichiometric compound. (auth)

19513 SYSTEM ZIRCONIUM–HAFNIUM–OXYGEN. Domagala, R. F. (Univ. of Illinois, Chicago); Ruh, Robert. ASM (Amer. Soc. Metals), Trans. Quart.; 62: 915-25(Dec 1969).

The phase relationships in the Zr-Hf-HfO_2-ZrO_2 portion of the Zr-Hf-O system were investigated by metallographic and x-ray diffraction analyses. Isothermal sections at 1,000, 1,400, 1,600, and 1,800°C were determined. At 1,000°C a narrow β field was formed in the Zr-rich corner of the diagram. With increasing oxygen content, there was an α plus β field which paralleled the β field. Adjacent to the two-phase field, there was a comparatively broad α field. Both α and β were Zr-Hf-O solid solutions; α had a hcp and β a bcc structure. At higher oxygen contents, there was an α plus oxide field where the oxide is a solid solution of ZrO_2. Beyond the two-phase region, the oxide phase existed over a small composition range. With increasing temperature, the other isothermal sections had the same general form except that the β and α plus β fields increased in size at the expense of the α field. (auth)

19514 THE PREPARATION AND CRYSTAL STRUCTURE OF Sc_4C_3. Krikorian, N. H.; Bowman, A. L.; Krupka, M. C.; Arnold, G. P. (Los Alamos Scientific Lab., N. Mex.). High Temp. Sci.; 1: 360-6(Oct 1969).

The structure of Sc_4C_3 was determined to be cubic, space group $I\bar{4}3d$, with 16 scandium atoms in 16(c) (xxx), x = 0.0496 ± 0.0006 and 12 carbon atoms in 12(a) ($\frac{3}{8}$ 0 $\frac{1}{4}$). The lattice parameter on the metal rich side was $a_0 = 7.2081 \pm 0.0004$ in equilibrium with Sc_2C (trigonal) and $a_0 = 7.2067 \pm 0.0002$ on the carbon rich side in equilibrium with the higher carbide phase ($ScC_{\sim 1.2}$). An apparent eutectic temperature for $ScC_{\sim 1.2}$ with graphite was determined as 1780°. (auth)

19515 UC–UC_2 PHASE BOUNDARIES. Benz, Robert; Hoffman, C. G.; Rupert, G. N. (Los Alamos Scientific Lab., N. Mex.). High Temp. Sci.; 1: 342-59(Oct 1969).

The U-C phase system was investigated by thermal, microscopic, x-ray diffraction, and chemical techniques with the following results: the UC and UC_2 congruent melting points occurred at the C/U ratios of 0.99 ± 0.02(2490 ± 40°) and 1.95 ± 0.05(2440 ± 35°), respectively; the C/U ratio at the UC_2-C eutectic was 2.02 ± 0.03(2430 ± 35°); the C/U ratio of carbon-saturated UC_2 increased from 1.905 ± 0.02 between 1500 and 1800° to 1.915 at 2000° and to 1.96 at the UC_2-C eutectic temperature; a peritectoid occurred at 1775 ± 25° where β-UC_2, with the C/U ratio of 1.78 ± 0.02, coexisted under equilibrium conditions with α-UC_2 (C/U = 1.77) + U_2C_3 phases; and U_2C_3 decomposed at the higher temperature of 1820 ± 25°. (auth)

19516 PHASE EQUILIBRIA STUDY ON THE V_nO_{2n-1} SYSTEM BY A SOLID ELECTROLYTE CELL. Okinaka, Hideyuki; Kosuge, Koji; Kachi, Sukeji (Kyoto Univ.) Jap. J. Appl. Phys.; 9: 224 (Feb 1970).

The phase equilibrium of the V_nO_{2n-1} system at 850 to 1300°K was studied by utilizing a solid electrolyte cell of the following type; Pt| neighboring two phase mixtures (V_nO_{2n-1} + $V_{n+1}O_{2(n+1)-1}$)| $(ZrO_2)_{0.85}(CaO)_{0.15}$|$O_2$ (air reference electrode)| Pt. The pressure-temperature diagram of the system is given. (G.M.C.)

19517 SUBSOLIDUS EQUILIBRIA IN THE SYSTEM ZrO_2–WO_3–P_2O_5. Martinek, Charles A.; Hummel, F. A. (Pennsylvania State Univ., University Park). J. Amer. Ceram. Soc.; 53: 159-61(Mar 1970).

The existence of stable and metastable forms of $2ZrO_2 \cdot P_2O_5$ and the subsolidus phase relations in the system $ZrO_2-ZrP_2O_7$ were confirmed before investigation of the ternary system. The synthesis and thermal behavior of ZrW_2O_8 were reinvestigated, and the system $WO_3-P_2O_5$ was examined cursorily. A ternary compound, $2ZrO_2 \cdot WO_3 \cdot P_2O_5$, was found, and compatibility triangles for the system between 1105 and 1150°C were established. The ternary compound was compatible with ZrO_2, WO_3, and three binary compounds, giving rise to five composition triangles. In addition, ZrP_2O_7, WO_3, and $W_2O_3(PO_4)_2$ were compatible. (auth)

19518 CRYSTAL STRUCTURE OF MONOCLINIC HAFNIA AND COMPARISON WITH MONOCLINIC ZIRCONIA. Ruh, Robert (Air Force Materials Lab., Wright-Patterson AFB, Ohio); Corfield, Peter W. R. J. Amer. Ceram. Soc.; 53: 126-9(Mar 1970).

The crystal structure of monoclinic HfO_2 was determined using Weissenberg techniques. Data were obtained from a needlelike single crystal which was grown from a lithium molybdate melt. The crystal was rotated about the α axis, and reflection data were obtained for nine levels. A three-dimensional least-squares refinement confirmed that monoclinic hafnia was isomorphous with monoclinic zirconia. The atomic coordinates in the structures agreed within one standard deviation. Thus, the fractional coordinates for the metal atom differed by less than 0.0005 and those for the oxygen atoms by no more than 0.01. Whereas three of the seven Hf–O distances were larger than the corresponding Zr–O distances, the average value was approximately 0.01 Å smaller. The average metal-metal distance was approximately 0.02 Å less in HfO_2 than in ZrO_2. (auth)

Radiation Effects

Refer also to abstracts 19523, 19955, and 19989.

19519 (EURFNR–685) COMPATIBILITY STUDIES WITH SIMULATED FISSION PRODUCTS ON STAINLESS STEEL AND MOLYBDENUM, WITH AND WITHOUT PRESENCE OF UO_2. Hofmann, P.; Thuemmler, F.; Wedemeyer, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Translation of report KFK–979. 86p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

This report was abstracted from the original language and appeared in NSA as 24: 3047. (J.R.D.)

19520 (NP–18151) FIRST IRRADIATION EXPERIMENTS ON UO_2–Mo AND UO_2–Cr CERMETS WITH 80 VOLUME PERCENT UO_2 IN Nb CANS. Dienst, W.; Weimar, P. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). 2 Oct 1969. 42p. (In German). Dep. CFSTI (U. S. Sales Only).

For irradiation tests, small fuel-rod specimens were prepared of UO_2–20 vol% Mo and UO_2–20 vol% Cr cermets with Nb-cladding. An idealized cermet microstructure was obtained by isostatic hot-pressing metal-coated UO_2 microspheres (about 100 μm diameter). Their properties were characterized by data on the bending strength, thermal conductivity, and thermal expansion of such cermets as functions of their metal content. 16 specimens of about 6.5 mm fuel diameter, 40 mm fuel length, 0.3 mm cladding thickness and 75 to 100% TD pressed density were irradiated in two NaK-filled capsules. The average rod-power was about 550W/cm, the cladding temperature 650°C, the uranium burnup 1 to 1.5%. UO_2–Mo samples of 75% TD tended to microcracking in the Mo-matrix. On the other hand, samples of very high density near 100% TD underwent cladding cracks by fission-product swelling of the fuel. The optimum density for avoiding fission gas release and swelling of the fuel rods appears to be 85 to 90% TD. The volume increase of the fuel samples amounted to 1.3 to 1.7%/% burnup for UO_2–Mo and to at least 2%/% burnup for UO_2–Cr. Probably, these relatively high values can be reduced by a stronger cladding, e.g., a nickel alloy. The 0.3 mm Nb-cladding, which was embrittled by a small oxygen content of the pressure gas during hot pressing, proved to be insufficient. All UO_2–Cr specimens (90 to 93% TD) showed cracks in the cladding and in the fuel. The worse irradiation behavior of these specimens can be due to the lower high-temperature strength, the lower thermal conductivity and the higher thermal expansion of the Cr-matrix compared with the Mo-matrix. By the larger thermal expansion coefficient a gap can be formed between fuel and cladding during cooling after hot pressing. (auth)

Plastics and Other Materials

Refer also to abstracts 19410, 19422, and 19965.

19521 (CONF-691002–, pp 705-11) A STUDY OF SOME OF THE FACTORS AFFECTING THERMAL PROPERTIES IN PACKED BED SYSTEMS. Schilmoeller, Neil H. (Argonne National Lab., Ill.).

Thermal property studies of vibratory compacted materials have shown a definite increase in conductivity with increase in density for a given material. This effect may, also, be described as a function of the decrease in porosity of the composite system, porosity being the percent void fraction. In order to examine the surface contact resistance and other effects an investigation has been conducted using similar particles of a material in various size ranges varying both the size and the mixture of sizes used. An effort is made to relate the observed changes in thermal properties on the basis of parameters of the packed bed system. The experimental study was carried out in connection with the problem of selecting the most appropriate fuel material makeup for the proposed fast reactor fuel assemblies. Parameters are needed to determine the optimum design for these elements from both the thermal and mechanical property points of view. Studies of the effect of the number of contact points and condition of these contact points are examples of the parametric studies which are important in this area. Measurements were made using an apparatus which incorporates a plane heat source which allowed the materials of the various sizes and combinations of sizes to be packed into the test chamber and mechanically vibrated to assure complete and uniform loading. Glass beads were chosen as the material since accurately sized particles of uniform quality can be easily obtained. Particles ranging in size from $-6 + 9 \rightarrow -40 + 50$ mesh size were used in the tests. All results reported are from tests made at room temperature using air as the coupling gas. (auth)

19522 (ORNL-TM-2860) AGING, WEATHERING, AND POISONING OF IMPREGNATED CHARCOALS USED FOR TRAPPING RADIOIODINE. Ackley, R. D.; Combs, Zell; Adams, R. E. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Aging, weathering (exposure to flowing air), and poisoning are processes which might adversely affect charcoal performance, especially with regard to trapping radioiodine in the form of methyl iodide (CH_3I). Accordingly, some effort has been applied toward investigating the effects of the above processes. The bulk of the data obtained corresponds to four different types of charcoal. Three types are iodized, thus providing isotopic exchange capability, and the other is triethylenediamine-impregnated. The influences of the processes were examined by observing the variation in ^{131}I of $CH_3{}^{131}I$ removal capability for the iodized charcoals or in CH_3I removal capability for the amine-impregnated charcoal. The results, which were generally in accord with expectation, indicated that aging per se has little or no effect on impregnated charcoal performance; weathering with air at around 50% relative humidity has an appreciable effect; and poisoning of iodized charcoal can have a large effect. (auth)

19523 (RN-S-534) BEARING RETAINER MATERIALS DEVELOPMENT. Final Report. Dessau, P. (Aerojet-General Corp., Sacramento, Calif. Nuclear Div.). Oct 1969. Contract SNP-1. 76p. Dep. CFSTI.

During the period January to June 1969, a series of 50-mm bearing tests were performed in liquid hydrogen with irradiated and unirradiated ball- and roller-bearing retainers fabricated from experimental materials. Several of these materials had been qualified by low- and high-speed wear tests, the results of which were reported in earlier reports. Results of testing during the current period, in addition to the results of testing of five parts previously reported, indicated that the major objective of the program (i.e., to develop radiation-resistant retainer materials) has been successfully achieved. Results of irradiation and bearing test performance are described. Several new, irradiated, reinforced polymers were tested. Of these, the PBI-glass material performed successfully in every respect, qualifying not only the material but an improved retainer configuration as well. The PBI-graphite roller retainers performed satisfactorily, also qualifying this material as a co-candidate for thrust-bearing-retainer application. Correlation between retainer wear rate and wear-test wear rate was demonstrated. (auth)

19524 MECHANICAL PROPERTIES OF WOOD-PLASTIC-COMBINATES MADE OF FOUR FINNISH WOOD SPECIES BY IMPREGNATION WITH METHYLMETACRYLATE OR POLYESTER AND GAMMA POLYMERISATION. Miettinen, Jorma K. (Univ. of Helsinki); Autio, Timo; Siimes, F. E.; Olilla, T. Valtion Tek. Tutkimuslaitos Julk.; No. 137, 1-58(1968).

The effects of plastic impregnation on the physical and mechanical properties of birch, alder, aspen, and pine woods were investigated. Methyl methacrylate and polystyrene were used. Summaries of methods and material specifications are included along with results of bend, elasticity, compression, tensile shear, fatigue, hardness, abrasion, and stability testing. (J.R.D.)

19525 RADIATION EFFECTS ON THE PROCESS OF SLUDGE PRECIPITATION. Klassen, V. I.; Malysheva, N. G.; Starchik, L. P. Tsvetn. Metal.; No. 1, 82-4(Jan 1970). (In Russian).

The effects of radiation on the rate of settling of suspended sludge (galenite, pyrite, quartz, calcite, albite, fluoride, and bosite) were studied using $^{90}Sr + {}^{90}Y$ ($\epsilon_{\beta max}$ = 2.15 MeV with activity of 500 Ci) and $^{144}Ce + {}^{144}Pr$ ($\epsilon_{\beta max}$ = 3.15 MeV and ~3 ci activity) sources. The duration of irradiation was from 30 min to 6 hr with an optimum exposure of 1 to 1.5 hr. It was found that the time interval after irradiation influenced the settlement. One hr after exposure was completed, the rate of precipitation was reduced about 50%. The electrolytically coagulated specimens differed from those that were radiation-coagulated. The latter consisted of larger more compact particles, was more dense, and contained smaller quantities of water which led to faster filtration. (R.V.J.)

19526 EFFECT OF ANOMALOUSLY LOW FRICTION IN VACUUM ON BOMBARDING POLYETHYLENE WITH STREAMS OF FAST ATOMS AND MOLECULES OF A NUMBER OF ELEMENTS. Dukhovskii, E. A.; Onishchenko, V. S.; Ponomarev, A. N.; Silin, A. A.; Tal'poze, V. L. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 189: 1211-4(21 Dec 1969). (In Russian).

The friction of polyethylene on steel was tested after irradiating polyethylene disks 5.5 cm in diameter and 0.5 cm thick with a stream of fast neutral helium atoms of about 10^{14} atoms per second. The neutral atoms were formed on accelerating charged helium ions and subjecting these ions to charge exchange with neutral helium atoms. No noticeable temperature rise could be detected in the polyethylene surface layer by measurement with a thermocouple during surface bombardment with the neutral helium atoms. The results showed that the coefficient of friction, which was constant at 0.10 to 0.13 when the polyethylene was not being irradiated, fell to a very low value of 0.001 within a period of 60 to 100 seconds after turning on the beam of neutral helium particles. After the beam is again turned off, the coefficient increased to its former value of 0.10 to 0.13 within a characteristic time of 350 to 500 seconds. Repetition of the experiment showed that the result was completely reproducible. Analogous results were obtained on bombarding polyethylene with argon, hydrogen, nitrogen and air particle streams. It is hypothesized that some mechanism involving saturation of the surface layer with a gas is responsible for this effect. (TTT)

PHYSICS (GENERAL)

Astrophysics and Cosmology

19527 APPLICATIONS TO ASTROPHYSICS. pp 801-72 of Physics of the One- and Two-Electron Atoms. /Bopp, F. (ed.). Amsterdam; North-Holland Publishing Co. (1969).

From Conference on Physics of the One- and Two-Electron Atoms, Munich, Germany. See CONF-680934.

Four review papers are included on the following subjects: hydrogenic spectral lines in radio astronomy, line broadening, dielectronic recombination and competing processes, and x radiation from the Sun. Numerous references are included. (A.G.W.)

Cosmic Ray Exposure Ages

19528 INERT GASES IN IRON METEORITES AND SPALLATION REACTIONS. Levskii, L. K.; Murin, A. N. (Leningrad State Univ.). Geochem. Int. (Engl. Transl.); 6: 365-9(1969).

Translated from Geokhimiya; No. 4, 478-83(1969).

The comparison of the relative content of cosmogenic isotopes of inert gases in iron meteorites and the yield of the same isotopes in spallation reactions in accelerators leads to the conclusion of a two-fold excess of cosmogenic helium and neon in meteorites. The relative content of surplus cosmogenic isotopes is considered, in particular in connection with the diffusion of tritium from iron meteorites. The question concerning the origin of surplus isotopes is left open. (auth)

19529 XENON FROM THE ANGRA DOS REIS METEORITE. Hohenberg, C. M. (Univ. of California, Berkeley). Geochim. Cosmochim. Acta; 34: 185-91(Feb 1970).

Xenon released in stepwise heating of the Angra dos Reis stone is found to be largely cosmogenic (from cosmic-ray spallation reactions) and fissiogenic (presumably from the spontaneous fission of 82 million year ^{244}Pu). This meteorite contains the largest proportion of these two components observed to date with some temperature fractions containing nearly pure spallation and fission-produced xenon. Unlike spallation xenon observed in the eucrites that results chiefly from barium, Angra dos Reis xenon apppears to have significant contributions from spallation reactions on rare earth targets. A previous report that Angra dos Reis contains fission xenon of a new type is not substantiated. (auth) (UK)

19530 RARE GASES ON THE EARTH AND IN METEORITES. Rao, M. N. (Tata Inst. of Fundamental Research, Bombay). Astrophys. Space Sci.; 6: 315-20(Feb 1970).

Analysis of abundance patterns of rare gases ^{22}Ne, ^{36}Ar, ^{84}Kr, and ^{130}Xe on Earth and in ordinary and carbonaceous chondrites is presented. A mechanism of chemical adsorption of rare gases at the planetesimal stage during their accretion is proposed to generate the abundance pattern of the heavy rare gases on the Earth. The calculated values for Xe and Kr agree well with the observed values whereas for Ar, the agreement is poor. (auth)

Stars

Refer also to abstract 20068.

19531 (JINR-P6-4902) SEARCH FOR SUPER-HEAVY ELEMENTS IN NATURE: BASES AND PERSPECTIVES. Flerov, G. N.; Karamyan, S. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1970. 36p. (In Russian). (CONF-690945-1). Dep. CFSTI (U. S. Sales Only).

From International Mendeleev Congress, Turin, Italy.

The existence of long-lived super-heavy elements in nature and their synthesis in stars are discussed. Theoretical predictions of physical and chemical properties of these elements were analyzed. Experimental results of the search for superheavy elements in nature and in cosmic rays are reviewed. The perspectives of development of experimental investigations in this direction are considered. (auth)

19532 NEUTRINO EMISSION, MASS LOSS, AND TERMINATION OF THE GIANT BRANCH IN YOUNG CLUSTERS. Stothers, Richard (Goddard Space Flight Center, New York). Astrophys. Lett.; 4: 187-9(Dec 1969).

Neutrino emission is shown to be able to account for the sudden termination of the giant branch in young clusters like NGC 1866, where the giants have originated from main-sequence stars of intermediate mass. However, an alternative interpretation based on rapid mass loss cannot yet be ruled out. (auth)

19533 ENERGY BUDGET FOR THE INFRARED RADIATION FROM ETA CARINAE. Pagel, B. E. J. (Royal Greenwich Observatory, Herstmonceux, Eng.). Astrophys. Lett.; 4: 221-4 (Dec 1969).

When corrections are applied for interstellar and intrinsic absorption, the inferred ultraviolet radiation of η Carinae carries about the right amount of energy to account for the infrared emission by radiative heating of dust grains. (auth)

19534 RELATIVE INTENSITIES OF BOWEN LINES. Nussbaumer, H. (University Coll., London). Astrophys. Lett.; 4: 183-6(Dec 1969).

Transition probabilities for allowed transitions in O III are given between all terms below $2p3d\,^1P^0$. An apparent discrepancy between observed and calculated line intensities $(2p3d\,^3P^0_2 - 2p3p\,^3P)/(2p3p\,^3S - 2p3s\,^3P^0)$ in planetary nebulae can be explained by including the two-electron transition $2p3p\,^3S - 2s2p^3\,^3P^0$. (auth)

19535 PHOTOMETRIC OBSERVATIONS OF RR LYRAE STARS. III. THE RR LYRAE GAP IN THE COLOR-MAGNITUDE DIAGRAM OF OMEGA CENTAURI (NGC 5139). Geyer, E. H.; Szeidl, B. (Univ., Bonn). Astron. Astrophys.; 4: 40-52 (Jan 1970).

Mean magnitudes, mean colors, and amplitudes for 45 RR Lyrae variables in the globular cluster ω Cen are presented. These are based on light curves in two colors measured on 78 B, V plates taken with the ADH Baker-Schmidt camera of the Boyden Observatory. The color boundaries of the region of instability of the RR Lyrae domain are in the range $0.15m \leqq (B-V) \leqq 0.42m$. The red boundary coincides with that of the globular cluster M3. In contrast to M3 there is no sharp color border between the c-type and ab-type variables, which is caused by the wider color range $0.15m \leqq (B-V)_d \leqq 0.34m$ of the RR_c stars. The interval of overlapping is $\Delta\,(B-V)_d \sim 0.09m$. There is also a possible overlap in color of type-c stars with nonvariable blue horizontal branch stars. The slope for the RR_{ab} stars in the period-color diagram of ω Cen is less steep than for the same stars in M3, whereas the slope for the RR_c variables is identical with that of M3. There seems to exist a second RR_c branch parallel shifted to longer periods. Also in ω Cen the pulsation criterion $P\sqrt{\bar{\rho}} = Q$ is fulfilled like in M3. Period luminosity relations seem to exist for the c type- and ab-type-variables which are not observed in M3. According to the calculations of Christy most of these results can be explained by a mass range of the RR_c and RR_{ab} stars and a higher helium content in their envelopes than in M3. (auth)

19536 THE MANGANESE MERCURY STAR π_1 BOOTIS. Montgomery, John Wm.; Aller, H. Lawrence (Univ. of California, Los Angeles). Proc. Nat. Acad. Sci. U. S.; 63: 1039-44 (Aug 1969).

High-dispersion plates secured with the Coudé spectrograph of the Lick 120-inch telescope were used to analyze the peculiar A star π_1 Bootis. Spectral-energy distribution measurements were combined with line-intensity data for iron and manganese in two stages of ionization to obtain a fit with model atmospheres for $T_{eff} = 13{,}000°K$ and $\log g = 4$. The influence of adopted T and g on the derived abundances is discussed. Although C, O, Mg, Si, Ti, Cr, and Fe appear to have nearly normal (i.e., solar) abundances, strontium appears to be enhanced in abundance by an order of magnitude, and scandium is about 50 times overabundant, while manganese and yttrium appear to be two orders of magnitude overabundant. If the identification of gallium is correct, this element is overabundant by a factor approaching 100,000; while if λ3983.90 is to be attributed to Hg II, as Bidelman suggests, the overabundance of this element is many orders of magnitude. (auth)

19537 ON THE PRODUCTION OF NUCLIDES WITH A > 250 IN STELLAR NUCLEOSYNTHESIS. Viola, V. E., Jr. (Univ. of Maryland, College Park). Nucl. Phys.; A139: 188-202(1969).

The r-process model of heavy element nucleosynthesis (Seeger, Fowler and Clayton) has been re-examined in order to investigate the possibility that super-heavy elements near the predicted doubly magic nucleus ^{298}114 may have been produced during stellar synthesis. On the basis of current data regarding heavy element fissionability, as well as nuclidic mass systematics, it is concluded the r-process should terminate below mass number $A \approx 275$. Consequently, heavier elements probably have not been formed naturally. The relationship of these results to the questions of uranium-thorium abundances in nature and the possible role of ^{254}Cf in Type I supernovae is also discussed. (auth)

19538 THE IONIZATION STRUCTURE OF PLANETARY NEBULAE. VIII. MODELS OF NEBULAE NGC 7662 AND IC 418. Flower, D. R. (University Coll., London). Mon. Notic. Roy. Astron. Soc.; 146: 243-63(1969).

Using computer programs which are based on the theory developed in the previous papers in this series a number of models of the planetary nebulae NGC 7662 and IC 418 were computed. An essential feature of the models is the inclusion of stellar atmosphere fluxes calculated by Hummer and Mihalas (private communication) which fit the observational data for the central stars of these two nebulae. A detailed comparison is made between observed and calculated forbidden line intensities and values derived for the abundances of nitrogen, oxygen, and neon relative to hydrogen in the nebulae. The value of the neon abundance is found to be substantially less than the mean values for B stars and for planetary nebulae given by Aller (1961 and 1964 respectively). It is shown that the intensity of the collisionally excited C IV λ1549 resonance doublet relative to the He II λ4686 recombination line is insensitive to the physical parameters of the model but sensitive to the probability of reabsorption of He II Ly-α photons produced in the nebula. Measurement of the intensity of the λ1549 line (from above the Earth's atmosphere) for a few high-excitation planetary nebulae would, therefore, be important to the understanding of the He II Ly-α transfer problem. (auth) (UK)

19539 SINGULARITIES OF GRAVITATIONAL COLLAPSE AND COSMOLOGY. Hawking, S. W. (Cambridge Univ., Eng.); Penrose, R. Proc. Roy. Soc. (London), Ser. A; 314: 529-48 (27 Jan 1970).

A new theorem on space-time singularities is presented which largely incorporates and generalizes the previously known results. The theorem implies that space-time singularities are to be expected if either the universe is spatially closed or there is an "object" undergoing relativistic gravitational collapse (existence of a trapped surface) or there is a point p whose past null cone encounters sufficient matter that the divergence of the null rays through p changes sign somewhere to the past of p (i.e., there is a minimum apparent solid angle, as reviewed from p for small objects of given size). The theorem applies if the following four physical assumptions are made: Einstein's equations hold (with zero or negative cosmological constant), the energy density is nowhere less than minus each principal pressure nor less than minus the sum of the three principal pressures (the "energy condition"), there are no closed timelike curves, every timelike or null geodesic enters a region where the curvature is not specially alined with the geodesic. (This last condition would hold in any sufficiently general physically realistic model.) In common with earlier results, timelike or null geodesic incompleteness is used as the indication of the presence of space-time singularities. No assumption concerning existence of a global Cauchy hypersurface is required for the present theorem. (auth) (UK)

19540 NONRADIAL OSCILLATIONS OF MASSIVE STARS BY VARIATIONAL METHODS. Andrew, A. L. (La Trobe Univ., Melbourne). Bull. Cl. Sci., Acad. Roy. Belg.; 54: 1046-55(1968).

Extension of a previous work (Andrew, 1967) is presented in which the Ritz method was applied to a variational principle of Chandrasekhar (1964) in order to determine numerically the normal modes of the nonradial oscillation of a massive star. A full fourth-order system of differential equations governing small, adiabatic, nonradial oscillations of stars is given. Results of the previous work are amended slightly and extended to take into account the perturbation of the gravitational potential. The reliability of the numerical process is considered in some detail. (IAA)

19541 SEARCH FOR METAL-DEFICIENT STARS. Bond, Howard Emerson. Ann Arbor, Mich.; Univ. of Michigan (1969). 177p. Thesis.

A search for previously unknown metal-deficient stars was carried out on objective-prism plates taken with the Curtis Schmidt telescope, with the purposes of increasing the number of such objects known and of investigating to what extent the properties of the previously known sample were due to selection effects. Four-color Strömgren photoelectric photometry was obtained for over 250 suspected metal-deficient stars found on the objective-prism plates. (TSS) (Diss. Abstr.)

19542 VISTAS IN ASTRONOMY. VOLUME 11. Beer, Arthur (ed.). Elmsford, N. Y.; Pergamon Publishing Company (1969). 280p. $20.00. (In English and French).

This volume contains thirteen reviews on various areas of astronomy. Separate abstracts were prepared for five of the papers. (W.D.M.)

For abstracts of individual papers see: 19543–19546 and 19671.

19543 PHOTOMETRY OF FAINT STARS. Lallemand, A. (Observatoire, Paris). Vistas Astron.; 11: 119-26(1969). (In French).

The problems posed by photometry in the UBV system, which allows photometric measurements of the weakest stars, are discussed. The most favorable conditions for obtaining the best precision with classical photographic plates are studied, as well as the characteristics that must involve the microphotometer that measures the images. Difficulties of calibration are then encountered if classical photographic emulsions are used. By using electronography, some improvements are possible in photographic measurements. This situation is due to the linear response of the electronograph which is conserved in the total density measurement of the stellar images with very precise conditions and with the microphotometry which is described. (tr-auth)

19544 NEW STOCKHOLM SPECTRAL SURVEY OF THE SOUTHERN MILKY WAY. Loden, Lars Olof (Stockholms Observatorium, Saltsjoebaden, Sweden). Vistas Astron.; 11: 161-71(1969).

A survey of the Southern Milky Way being carried out at the Stockholm Observatory is briefly described. Photographic and photoelectric material, obtained at the Boyden Observatory in South Africa, is used for the selection of interesting objects, and for a preliminary classification and photometry of these objects to facilitate subsequent detailed investigations. Some comments are added concerning the procedures involved, and also relating to a special program concerned with the search for associations, which may lead to interesting results. (auth)

19545 DEPENDENCE OF THE VELOCITY BODY OF STARS ON SPACE LOCATION. Rudnicki, K. (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena. Warsaw Univ. Observatory). Vistas Astron.; 11: 173-80(1969).

The velocity body of physically homogeneous subsystems of stars is assumed to be practically constant in space, because of the widely accepted so-called Dynamical Theory of a Stationary Galaxy. This theory can be considered today to be only one of many possible solutions of the dynamical equations. This solution is not fulfilled in our Galaxy. Thus no arguments can be stated in favor of the opinion that the velocity body in our surroundings does not depend on space location. On the contrary, some theoretical considerations, as well as observational implications, bring one to the conclusion that changes of parameters of the velocity body of homogeneous subsystems of stars can be significant even in distances as small as some hundred parsecs. (auth)

19546 THEORETICAL STUDY OF GALACTIC NOVAE. Sobolev, V. V. (Leningrad State Univ.). Vistas Astron.; 11: 181-8(1969).

This article briefly sets forth the results of some theoretical papers on the study of novae. Topics discussed include detachment of the envelope from the star, envelope luminosity in the first period of the outburst, motion of the envelope, and intensities of emission lines. (W.D.M.)

19547 DIAMAGNETIC ZEEMAN EFFECT AND MAGNETIC CONFIGURATION MIXING IN LONG SPECTRAL SERIES OF Ba I. Garton, W. R. S.; Tomkins, F. S. (Argonne National Lab., Ill.). Astrophys. J.; 158: 839-45(Nov 1969).

Diamagnetic shifts and pronounced effects of mixing between the magnetic sublevels of configurations of differing l and n were observed in the principal series of Ba I, photographed in absorption to about the n = 75 member with a 30-foot spectrograph. An unexpected feature of the spectra is the presence of almost equally spaced absorption maxima, in σ polarization, which extend across the zero-field series limit to well inside the corresponding ionization continuum, with an interval of about 1.5 times the σ splitting. (auth)

19548 A COMPARISON OF RADIO-FREQUENCY AND OPTICAL STUDIES OF SELECTED PLANETARY NEBULAE. Aller, L. H. (Univ. of California, Los Angeles). Proc. Astron. Soc. Aust.; 1: 283-5(Sep 1969).

Radio and optical Hβ fluxes are compared for nebulae, whose space absorption and electron temperature have been determined from optical data and radio data at 11 cm. (auth)

19549 HIGH-DISPERSION SPECTROSCOPY AND INTERPRETATION OF STELLAR ATMOSPHERES. Aller, L. H. (Univ. of California, Los Angeles). Proc. Astron. Soc. Aust.; 1: 264-8 (Sep 1969).

Progress in observational techniques, and advances in theory, made possible by the adaption of the high-speed computer, are exemplified in the investigation of supposedly normal stars, high-temperature stars, and some pathological stars providing

difficulties in interpretation by current theories of nucleogenesis. (Australia)

19550 ON THE POSSIBILITY OF OBSERVING INTERFEROMETRICALLY THE SURFACE DISTORTION OF RAPIDLY ROTATING STARS. Johnston, Ian D.; Wareing, Nial C. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc.; 147: 47-58(1970).

The disc of a star which is rotating is neither circular nor uniformly bright, and therefore interferometric observations are in principle capable of yielding valuable information about such a star. The response of an interferometer to a rotating star is analysed, firstly by a perturbation calculation, applicable only to stars which rotate slowly, and then numerically, specifically for the two stars Regulus and Altair. These calculations assume the star is limb-darkened and gravity-darkened according to standard models of stellar atmospheres, and a separate calculation is made for stars with nonspherical gravitational fields. It is concluded that observations of rotational distortion are probably only marginally feasible with present-day equipment, though future interferometers should find them easy. However, even with present sensitivity, it should be possible to detect whether or not a star is in a state of extreme differential rotation. (auth)

19551 ROTATION AND CHEMICAL ABUNDANCES IN THE PECULIAR A STARS. I. Durrant, C. J. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 59-73 (1970).

The classifications and atmospheric structures displayed by early-type peculiar stellar spectra are compared empirically with those of normal stars. It is concluded that the structures of the metal-line-forming regions of the atmospheres of the peculiar A and B stars are identical with those of the normal stars of the same hydrogen type. A consistent temperature sequence can be established for both types later than spectral type B5. The differences in metal line strengths in stars of similar hydrogen type can be interpreted only as differences of abundance in the atmospheres. (auth)

19552 ROTATION AND CHEMICAL ABUNDANCES IN THE PECULIAR A STARS. II. Durrant, C. J. (Observatories, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 75-93 (1970).

New measurements of the distribution of silicon line strengths amongst early-type stars having similar atmospheric structures do not allow a clear-cut separation into normal and anomalous types. It is shown that those stars having line strengths much larger than the mean tend to have rotational velocities less than 200 km s^{-1}. It is likely that in many, if not most, strong-line stars no single temperature and pressure parameters will suffice to describe the atmosphere, and the assumption of a mean temperature can lead to large errors in the derived abundances of all but a few elements. The production of stars described by the oblique rotator model is discussed briefly. (auth)

19553 IONIZATION FRONT INTERACTIONS IN INTERSTELLAR GAS. Marsh, M. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 95-114(1970).

An investigation was made into the interaction between a rapidly expanding planar H II region, bounded by a weak R-type ionization front, and a contact discontinuity which separates two regions of unionized gas of differing densities in the H I region. In order to determine a unique resultant flow configuration it was found necessary to supplement the equations of mass, momentum, energy, and radiation flux with Axford's ionization front structural analysis. This is particularly important when strong D-type fronts are evolved. It was found that an interaction with high-density gas results in the evolution of a slow-moving weak D-type front with an isothermal shock reflected towards the illuminating star. This result is used qualitatively to deduce the gas-dynamics of elephant trunks which, it is suggested, may be formed after a collision between an H II region and a relatively small globule of high-density gas. The bright rims which have been observed to bound these structures are regions of gas compressed by the passage of the reflected isothermal shock. (auth)

19554 QUASI-PERIODIC OUTBURSTS IN THE WHITE DWARF HARO–LUYTEN TAURUS NO. 76. Warner, Brian; Nather, R. Edward (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 147: 21-6(1970).

Photometric observations made with the 82-inch Struve reflector confirm Landolt's (1968) discovery that HL-Tau 76 is a variable star. The variations are quasi-periodic, with a time-scale of about 12.44 minutes and an amplitude ~0.3 magnitudes in white light. The light curve shows similarities to that of dwarf novae, but on a much shorter time-scale. (auth)

19555 STELLAR AND PLANETARY SPECTRA IN THE INFRARED FROM 1.35 TO 4.10 MICRONS. Forbes, F. F.; Stonaker, W. F.; Johnson, H. L. (Univ. of Arizona, Tucson). Astron. J.; 75: 158-64(Mar 1970).

Infrared spectra of late-type stars and some planets have been obtained through the use of an infrared spectrometer using a rotating, circular, variable-thickness interference filter. The resolution of these spectra is of the order of 100 ($=\Delta\lambda/\lambda$) over the interval 1.35 to 4.10 μ. The spectra of normal M stars indicate a positive luminosity effect based on the first and second overtones of CO. All three Mira variables observed exhibit stellar steam absorption. NML Cygnus and NML Taurus show extremely red energy distributions as expected. Features in the spectrum of NML Cygnus, which may be interpreted as the first overtone of CO, would seem to confirm its identity as a supergiant provided it is of normal composition. (auth)

19556 MK CLASSIFICATIONS FOR F- AND G-TYPE STARS. II. Harlan, E. A.; Taylor, D. C. (Univ. of California, Santa Cruz). Astron. J.; 75: 165-6(Mar 1970).

Mk spectral classifications are given for 166 stars of HD types F2–G5, and having $m_V = 7.5$ or brighter. The classifications were made on slit spectrograms of dispersion 75 Å/mm. (auth)

19557 SECONDARY UBV COMPARISON STARS NEAR SOME SOUTHERN GLOBULAR CLUSTERS. I. STARS BRIGHTER THAN 16th MAGNITUDE. White, Raymond E. (Univ. of Arizona, Tucson. Cerro Tololo Inter-American Observatory, La Serena, Chile). Astron. J.; 75: 167-8(Mar 1970).

The results concerning photoelectrically observed UBV magnitudes and colors of bright to intermediately faint stars near three southern globular clusters (NGC 2808, 5927, and 6101) are assembled. Finder charts for the stars observed in the vicinity of each cluster are also included. (auth)

19558 THE USE OF UBVr PHOTOMETRY FOR THE DISCOVERY OF PECULIAR STARS. Mannery, Edward J.; Wallerstein, George (Univ. of Washington, Seattle). Astron. J.; 75: 169-70(Mar 1970).

By plotting the ultraviolet excess, $\delta(U-B)$ against the index ΔM_4, it is easy to isolate barium, CH, and carbon stars. These peculiar stars can be distinguished from metal-poor, metal-rich, or composite stars. (auth)

19559 A CATALOGUE OF STELLAR ASSOCIATIONS IN THE LARGE MAGELLANIC CLOUD. Lucke, Peter B.; Hodge, Paul W. (Univ. of Washington, Seattle). Astron. J.; 75: 171-5(Mar 1970).

Stellar associations in the Large Magellanic Cloud are catalogued and described. The number of stars brighter than $V \approx 14.7$, listed for each of the 122 associations, ranges from 2 to 225, and the apparent diameters range from 1′ to 20′. (auth)

19560 NONLINEAR LIMB DARKENING FOR EARLY-TYPE STARS. Klinglesmith, D. A.; Sobieski, S. (Goddard Space Flight Center, Greenbelt, Md.). Astron. J.; 75: 175-82(Mar 1970).

A set of coefficients was obtained by fitting an empirical nonlinear limb-darkening law of the form $I(\mu)/I(1) = 1 - A_\lambda(1-\mu) - B_\lambda\mu \log \mu$ to values of $I(\mu)/I(1)$ computed from a grid of hydrogen line-blanketed model atmospheres. In addition, a set of coefficients for the conventional linear law was calculated. The comparison with previous theoretical values for the linearized law showed good agreement with Grygar's (1965) results but systematically smaller values than those found by Hosokawa (1967). (auth)

19561 WAVELENGTH DEPENDENCE OF POLARIZATION. XXI. R MONOCEROTIS. Zellner, Ben (Univ. of Arizona, Tucson). Astron. J.; 75: 182-5(Mar 1970).

Strong, variable optical polarization is found for the diffuse object R Monocerotis, which is generally believed to be a protoplanetary system. The wavelength dependence was almost flat in the winter of 1968–69, but more recently the polarization increases into the near infrared. The observations apparently rule out electron scattering or Rayleigh scattering as a source of the polarization, but may be compatible with scattering by larger grains. A survey of nine other objects located in cometary nebulae revealed no polarizations of comparable strength. (auth)

19562 FLUX DENSITIES OF PLANETARY NEBULAE AT 8.0 AND 16.2 GHz. Ehman, Jerry Ray. Ann Arbor, Mich.; Michigan Univ. (1969). 90p.

Thesis.

Observations of 70 planetary nebulae at a frequency of 8.0 GHz (3.75 cm wavelength) with the University of Michigan's 85-foot

radio telescope gave values of flux density above 0.1×10^{-26} W m^{-2} Hz^{-1} (corresponding to an antenna temperature of 0.009°K) for 46 nebulae. The remaining 24 were too weak to give useful values. Nine of the strongest nebulae were also measured at 16.2 GHz (1.85 cm wavelength). The planetary nebulae NGC 3242 and NGC 6781, previously known to be confused by nonthermal sources nearby, have values of flux density consistent with thermal spectra for these nebulae. No convincing evidence exists that any of the nebulae measured here have nonthermal spectra. IC 418, NGC 6572, and NGC 7027 have spectra indicating that either the electron temperature or the density, or both, are not constant throughout these nebulae. Several nebulae appear to have an optical depth greater than or comparable to unity at 8.0 GHz, implying large electron densities and thus small radii. This appears to be discordant with the results from optical measurements for some of these nebulae unless O'Dell's assumption that all planetary nebulae have the same mass is ruled out. Values of optical depth at 8.0 GHz, emission measure and electron density are calculated from the measured flux densities at 8.0 GHz for 46 nebulae. These electron densities are roughly a factor of 4 times smaller than corresponding values calculated from Hβ emission. Different emitting regions for the radio and Hβ emission is the most likely explanation. (Diss. Abstr.)

19563 THE PRE-MAIN SEQUENCE AND EARLY MAIN-SEQUENCE EVOLUTION OF STARS IN THE MASS RANGE 0.06 TO 0.10 $M_\odot$. Grossman, Allen Stuart. Bloomington, Ind.; Indiana Univ. (1969). 281p.

Thesis.

The structure and pre-main sequence evolution of stars in the mass range 0.06 $M_\odot$ to 0.10 $M_\odot$ were investigated at the composition X = 0.68, Y = 0.29 and Z = 0.03. The principal question investigated was whether a 0.1 $M_\odot$ star can stabilize itself on the main sequence at this composition. (TSS) (Diss. Abstr.)

19564 STRATIFICATION OF DISCRETE EMISSION LAYERS IN ATMOSPHERES OF LONG-PERIOD VARIABLE STARS. Swings, Jean-Pierre (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg.; 55: 553-9(1969). (In French).

The behavior of [Fe II] lines and A10 bands in long-period variables was examined and is discussed from the point of view of stratified models of the emitting layers of these objects. (auth)

19565 HOW ARE NEUTRON STARS FORMED. Cameron, A. G. W. Comments Astrophys. Space Phys.; 1: 172-7(Sep-Oct 1969).

At the present time people believe neutron stars to be observed, but there is no theoretical route for their formation. The author shows how this situation has come about. An alternative route toward neutron-star formation is suggested that features a star of mass greater than the white-dwarf mass limit, but not much greater, so that in a very late stage of stellar evolution it contracts rather slowly. (W.D.M.)

19566 TRANSITION PROBABILITIES FOR THE CYANOGEN $B\ ^2\Sigma^+$-$X\ ^2\Sigma^+$ TRANSITION. Liszt, Harvey S.; Hesser, James E. (Princeton Univ., N. J.). Astrophys. J.; 159: Pt. 1, 1101-5(Mar 1970).

Radiative lifetimes for the first three vibrational levels of the $B\ ^2\Sigma^+$ state in CN were determined by using the Lawrence phase-shift experiment, with the result that $\langle\tau(v = 0, 1, 2)\rangle = 59.3 \pm 6.0$ nsec. (auth)

19567 INFLUENCE OF NONCOHERENT ELECTRON SCATTERING ON A LINE PROFILE IN WOLF-RAYET STARS. Castor, J. I.; Smith, L. F.; Van Blerkom, D. (Univ. of Colorado, Boulder). Astrophys. J.; 159: 1119-21(Mar 1970).

The λ3483 line of N IV in the WN 6 star HD 192163 is observed to have a P Cygni-type profile, except for the presence of very extensive emission wings. It is shown that noncoherent scattering by free electrons in the W-R envelope can account for this profile. (auth)

19568 INFRARED STUDIES OF GALACTIC NEBULAE. I. NGC 6523, NGC 6572, AND BD 30°3639. Gillett, F. C. (Univ. of California, San Diego); Stein, W. A. Astrophys. J.; 159: 817-22(Mar 1970).

Observations from λ = 3 μ to λ = 14 μ were made of the galactic diffuse nebula NGC 6523 (M8) and two planetary nebulae BD 30°3639 and NGC 6572. The results are compared with earlier observations of the Orion Nebula and the planetary nebula NGC 7027. The possible sources of the infrared energy observed from the "hourglass" region of M8 are discussed. The star Herschel 36 can supply the necessary energy, if the infrared source in M8 is extended. However, difficulties associated with the temperature of particles in the source arise with this interpretation. Alternatively, the object in M8 could be either a star in the process of formation or a recently formed star within an optically thick cloud of dust. The observations show differences in the shape of the spectra of the planetaries which indicate either variations in temperature or differences in chemical composition. (auth)

19569 EMISSION-LINE PROFILES IN THE PLANETARY NEBULA IC 418. Osterbrock, D. E. (Univ. of Wisconsin, Madison). Astrophys. J.; 159: 823-7(Mar 1970).

Measurements are presented of H I, [N II], and [O III] emission-line profiles at the center of IC 418. The observed profiles are in qualitative agreement with published theoretical models of expanding planetary nebulae. However, detailed comparison shows discrepancies, particularly in the overlap of the [O III] and [N II] distribution functions of the emission coefficient, which indicate important deviations from spherical symmetry. (auth)

19570 [O I] λ6300 EMISSION IN PLANETARY NEBULAE. Williams, Robert E. (Univ. of Arizona, Tucson). Astrophys. J.; 159: Pt. 1, 829-32(Mar 1970).

The presence of [O I] λ6300 radiation in planetary nebulae is explained in terms of high-density condensations. It is found from ionization calculations of model nebulae that inhomogeneities can contribute appreciably to the emission of [O I], and [N II] lines, particularly in the more evolved, density-bounded nebulae. (auth)

19571 NONRADIAL PULSATION OF GENERAL-RELATIVISTIC STELLAR MODELS. V. ANALYTIC ANALYSIS FOR l = 1. Campolattaro, Alfonso (Univ. of California, Irvine); Thorne, Kip S. Astrophys. J.; 159: Pt. 1, 847-58(Mar 1970)

The theory of small, adiabatic, dipole perturbations of a star away from hydrostatic equilibrium is developed within the framework of general relativity. The analysis is linearized in the perturbation amplitudes. The "odd-parity" perturbations describe differential rotation, while the "even-parity" perturbations describe pulsation. In the pulsational case there are two degrees of freedom associated with the fluid motion and no degrees of freedom in the gravitational field (no dipole gravitational waves). During the pulsation the star's external gravitational field is completely unperturbed, to first order in the amplitude, despite the fact that its surface performs a finite, back-and-forth motion. In both the pulsational and rotational cases, the Einstein field equations are put into simple forms suitable for numerical integration. (auth)

19572 PULSATION ANALYSIS FOR STARS IN THERMAL IMBALANCE. Simon, Norman R. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 159: 859-70(Mar 1970).

The effects of thermal imbalance ($dS_t/dt \neq 0$) on stellar pulsational stability have largely been ignored in the literature. Here the linear, quasi-adiabatic pulsation theory is used to make a preliminary investigation of such effects. Analyses of the standard model and of a white dwarf show that, for these cases, "ordinary" terms in the stability integrals greatly outweigh the "extra" terms considered. The latter become more important when substantial ionization zones exist in the stellar matter. It is argued that the influence of thermal imbalance on pulsational stability should be quite small for stars crossing the H-R diagram in early post-main-sequence evolution, and for cooling degenerate stars. On the other hand, during pre-main-sequence contraction the thermal-imbalance terms are more likely to be important, and for thermal runaways in shell-burning stars these terms are almost certainly crucial. (auth)

19573 THE EFFECT OF MASS LOSS ON A CONTRACTING STAR. Kuhi, L. V. (Univ. of California, Berkeley); Forbes, J. E. Astrophys. J.; 159: 871-7(Mar 1970).

An attempt has been made to simulate the T Tauri phase of pre-main-sequence evolution by including a simple scheme for mass loss. Four stellar models have been calculated for intercomparison: two with initial mass 1.5 $M_\odot$ and final mass 1,2146 $M_\odot$, with rates of mass loss calculated by different prescriptions; and two with constant masses of these same two values. The final zero-age main-sequence position of the cases with mass loss corresponds exactly to the final mass; more surprisingly, the time scale for contraction to the main sequence also nearly corresponds to the final mass, the higher mass loss during the early Hayashi phase having little effect. A naive treatment of the ejection suggests that for observationally reasonable rates of mass loss the observed effective temperatures may reach low enough values to be well within the Hayashi forbidden region set by the fully convective condition. Some of the features observed in the H-R diagram of NGC 2264 seem explainable in terms of mass loss during the pre-main-sequence phase. (auth)

19574 MASS LOSS BY HOT STARS. Lucy, L. B.; Solomon, P. M. (Columbia Univ., New York). Astrophys. J.; 159: 879-93 (Mar 1970).

A mechanism is proposed to explain the mass loss observed for luminous, hot stars. It is shown that the ultraviolet resonance lines of ions such as Si IV, C IV, N V, and S VI can give strongly negative effective gravities in the outer parts of the reversing layers of hot stars. It is argued that a static reversing layer is then no longer possible and that a continuous outflow of mass occurs. To calculate rates of mass loss resulting from this mechanism, the problem of steady-state, moving reversing layers is formulated. From numerical solutions of the equations of this problem, the rate of mass loss is found to be $\lesssim L/c^2$; the evolution of the star is therefore not disturbed significantly. The domain in the (log T_{eff}, log g)-plane where the greatest rates of mass loss are expected is also approximately determined and found to be roughly consistent with observation. Finally, the problem of the supersonic flow to large distances from the star is briefly discussed. (auth)

19575 STUDIES IN STELLAR EVOLUTION. IX. THEORETICAL ISOCHRONES FOR EARLY-TYPE CLUSTERS. Simpson, Erik; Hills, R. E.; Hoffman, Wilson; Kellman, Sanford A.; Morton, Erwin Jr.; Paresce, Francesco; Peterson, Charles (Univ. of California, Berkeley). Astrophys. J.; 159: 895-901(Mar 1970).

Theoretical isochrones are constructed for stars of intermediate mass with a solar-type chemical composition of X = 0.730, Y = 0.245, and Z = 0.025. The effects of small changes in helium abundance are investigated by means of other isochrones computed with X = 0.700, Y = 0.275, and Z = 0.025. The effect on the isochrones is negligible. The isochrones are then fitted to some diagrams of galactic clusters in an effort to determine their ages and distances. Some difficulties encountered and possible explanations are discussed. (auth)

19576 FINAL EVOLUTION OF A LOW-MASS STAR. I. Rose, William K.; Smith, Richard L. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 159: 903-12(Mar 1970).

The evolution of models for an 0.85 $M_\odot$ star is followed from the initial stage of helium burning in a shell to the white-dwarf stage. For most of its final evolution, the star is ascending the red-giant branch for the second time. The burning of helium in a shell takes place in a series of shell flashes that are characterized by increasing peak rates of generation of nuclear energy. The helium shell attains nearly degenerate conditions when the star has evolved to luminosities in the neighborhood of 10^4 $L_\odot$. The calculations indicate that a helium flash in a shell will not lead directly to a dynamical event prior to this latter evolutionary stage. The important question of whether helium flashes in a shell that take place under nearly degenerate conditions can lead directly to a dynamical event, such as might in turn lead to the formation of planetary nebulae, will be studied in a subsequent paper. Processes of neutrino emission that are predicted by a direct electron–neutrino interaction cool the interiors of the computed models and prevent by a wide margin the onset of carbon burning. When the mass of the hydrogen-rich envelope has been reduced to about 2% of the total mass, the star evolves off the red-giant branch. The interval of time (~4000 years) that the star, in its subsequent evolution, spends in the region of the H–R diagram occupied by the central stars of planetary nebulae is substantially shorter than that indicated by the observations (~17000 years). This discrepancy may be related to the mechanism of mass loss. (auth)

19577 STELLAR REACTION RATES FOR ^{28}Si. Lyons, P. B. (California Inst. of Tech., Pasadena); Toevs, J. W.; Barnes, C. A.; Fowler, William A.; Sargood, D. G. Astrophys. J.; 159: 913-17 (Mar 1970).

Stellar rates for the reactions $^{27}Al(p,\gamma)^{28}Si$ and $^{24}Mg(a,\gamma)^{28}Si$ have been calculated from new cross-section data for these reactions. The contributions to the interaction rates, $\langle\sigma v\rangle_{p\gamma}$ and $\langle\sigma v\rangle_{a\gamma}$, and to the corresponding photodisintegration rates, $\lambda_{\gamma p}$ and $\lambda_{\gamma a}$, from the excited states of ^{27}Al, ^{24}Mg, and ^{28}Si are discussed. The calculated interaction rates, $N_A\langle\sigma v\rangle$, are listed for temperatures from 0.1×10^9 °K to 5.0×10^9 °K; two- and four-parameter fits are given for $N_A\langle\sigma v\rangle$ as a function of temperature. (auth)

19578 THE FREQUENCY OF SPECTROSCOPIC BINARIES IN NGC 6475. Abt, Helmut A. (Kitt Peak National Observatory, Tucson, Ariz.); Levy, Saul G.; Baylor, Lynn A.; Hayward, Robert R.; Jewsbury, Clifford P.; Snell, Charles M. Astrophys. J.; 159: 919-26(Mar 1970).

This cluster is known to have unusually low projected rotational velocities among its B stars, in contrast to the Pleiades, a cluster of the same age, which has unusually high rotational velocities. In NGC 6475 eight of the nineteen brightest main-sequence stars are found to be short-period spectroscopic binaries; orbital elements are given for these. This frequency is high relative to that for field stars and especially high relative to that for the Pleiades, among whose B stars no short-period binaries were found. It is concluded that low rotational velocities are probably caused primarily by tidal interactions in binary systems and that open clusters differ significantly in their binary frequencies. (auth)

19579 ULTRAVIOLET SPECTROPHOTOMETRY OF CANOPUS FROM GEMINI XI. Kondo, Y.; Henize, K. G.; Kotila, C. L. (Manned Spacecraft Center, Houston, Tex.). Astrophys. J.; 159: 927-30(Mar 1970).

The energy curve of Canopus in the wavelength range 2400 to 4000 Å was obtained from spectrograms having a dispersion of 183 Å mm^{-1}. This curve is in good agreement with previous observations and with a model atmosphere. The equivalent width of the Mg II doublet at 2795 and 2802 Å was found to be 22 Å. (auth)

19580 THE CONTINUOUS RADIATION OF BRIGHT B3 V STARS. Kodaira, Keiichi (Mount Wilson Observatory, Pasadena, Calif.). Astrophys. J.; 159: 931-43(Mar 1970).

Spectrophotometry from λ3297 to λ7850 is presented for twenty-seven B3 V stars brighter than 5.6 mag in the northern sky. No serious discrepancy is found between the observed and theoretical continua when a model atmosphere of T_e = 9600° K and log g = 4.0, calculated by Mihalas, is adopted for the primary standard a Lyr, according to the system of Oke. Apparent effective temperatures are determined for the stars in this program by comparing the colors and Balmer jumps with those of model atmospheres. Most of the observed B3 V stars are found to have an effective temperature between 16000° and 18000° K. An excessively large Balmer jump observed for some rapidly rotating stars is discussed with special attention to the effect of rotation on the fluxes. (auth)

19581 SUBLUMINOUS STARS. VI. PHOTOELECTRIC OBSERVATIONS IN THE RED AND NEAR-INFRARED. Eggen, Olin J. (Australian National Univ., Canberra). Astrophys. J.; 159: 945-9(Mar 1970).

The apparent bifurcation in the distribution of subluminous stars in the (M_v, U − V) plane is shown, from observations in the (R,I)-system, to be a probable feature of the distribution in the (M_{bol}, log T_e)-plane. (auth)

19582 A FINE ANALYSIS OF TWO YELLOW SUPERGIANTS. II. THE CONTINUOUS ENERGY DISTRIBUTIONS. Parsons, Sidney B. (Case Western Reserve Univ., Cleveland). Astrophys. J.; 159: 951-62(Mar 1970).

Continuum energy distributions from model atmospheres, with appropriate corrections for line absorption, are compared with stellar continuum observations. Deviations from LTE are included in the calculation of continuous opacity, but the effects on the emergent fluxes are small. Scanner observations of a Per show good agreement with the models, although there is ambiguity in the implied effective temperature and color excess. The angular diameter is well determined, and the distance modulus suggests a radius of about 60 $R_\odot$. Broad-band color indices are computed in the UBV and six-color systems. The color–color plot in the UBV system shows definite separation of the models, but not of temperature versus reddening effects. There is good agreement between observed and computed colors in the Stebbins and Kron UVBGRI system for a large sample of mid-type supergiants, including classical Cepheid variables. Assumption of effective temperatures for a Per and β Aqr allows relative determination of T_e, log g, and E_{B-V} for the other stars. (auth)

19583 SPECTRAL OBSERVATIONS, 1965–1968, OF THE PECULIAR EMISSION OBJECT V1016 CYGNI (MHα328-116). FitzGerald, M. P. (Univ. of Waterloo, Ont.); Houk, Nancy. Astrophys. J.; 159: Pt. 1, 963-72(Mar 1970).

Identifications and intensities are given for approximately 130 emission lines between 3130 and 5030 Å measured on fifteen spectrograms, with dispersions ranging from 12 to 130 Å mm^{-1}, taken during the 1965–1968 seasons. The line intensities and ratios do not give a completely consistent detailed picture; however, they do indicate that the temperature of the emitting regions increased from 1965 through 1967, and possibly through early 1969, and that the density decreased. The continuum remains very weak, and no absorption lines are seen. The radial velocity is −60 ± 1.5 km sec^{-1}, and the line widths (from the 12 Å mm^{-1} plates) are 80–120 km sec^{-1}. Upper limits to radio emission from V1016 Cyg by Bell and Seaquist and by Webster are 0.1 f.u. at 4.6 cm and 0.07 f.u. at 11.1 cm. The object may be reaching maximum light; photoelectric results by Fernie and Philip show that V, B–V, and U–B remained essentially constant throughout 1968. The object V1016 Cyg may well be a planetary nebula in the early stages of its evolution. (auth)

19584 HARMONIC ANALYSIS OF RIGIDLY ROTATING Ap STARS. Deutsch, Armin J. (Mount Wilson Observatory, Pasadena, Calif.). Astrophys. J.; 159: 985-99(Mar 1970).

To facilitate mapping the surfaces of magnetic- and spectrum-

variable stars, the requisite formulae are given for the harmonic analysis outlined in an earlier publication. (auth)

19585 THE ORIENTATION OF MAGNETIC AXES IN THE MAGNETIC VARIABLES. Landstreet, John D. (Columbia Univ., New York). Astrophys. J.; 159: 1001-7(Mar 1970).

The distribution of magnetic field over the surface of a star required to reproduce observed magnetic curves of Ap stars on the rigid-rotator model is discussed, and it is shown that the field distribution may be taken to be axisymmetric but is not necessarily antisymmetric to reflections through the magnetic equator. A statistical method for determining the angle β between the rotation and magnetic axes, devised by Preston, is extended to the class of models considered here, and it is shown that most magnetic stars have β near 90° independently of the precise field distribution over the surface which is assumed. (auth)

19586 INFRARED CN BANDS IN M SUPERGIANTS AND CARBON STARS. Wing, Robert F. (Ohio State Univ., Columbus); Spinrad, Hydron Astrophys. J.; 159: 973-83(Mar 1970).

Bands of the red system of CN in the region 1.1 to 2.5 μ have been identified in published spectra of M supergiants and carbon stars; their strengths are consistent with the observations of red CN bands in the 1-μ region. The CN features longward of 1.1 μ in M supergiants had previously been attributed to H_2O; the revised identifications indicate that these stars have oxygen/carbon ratios very close to unity. In carbon stars the CN bands produce broad and deep depressions which cause an apparent weakening of the rotation-vibration bands of CO; the observed differences in CO strength among carbon stars are caused primarily by differences in the CN abundance. It is noted that the red system of CN is probably the most important of all bound–bound sources of opacity in K giants, K and M supergiants, and carbon stars. (auth)

19587 THEORY OF RADIATIVE TRANSFER IN INHOMOGENEOUS ATMOSPHERES. III. EXTENSION OF THE PERTURBATION METHOD TO AZIMUTH-INDEPENDENT TERMS. Abhyankar, K. D.; Fymat, A. L. (California Inst. of Tech., Pasadena). Astrophys. J.; 159: 1009-18(Mar 1970).

In the case where the phase matrix, corresponding to the azimuth-independent term of the radiation field scattered by an inhomogeneous plane-parallel atmosphere, is separable in the form $P^{(0)}(\mu, \mu') = M(\mu) \cdot M^{\dagger}(\mu')$ (where the dagger stands for simple transposition), the simplified matrix equations of the problem are treated by the perturbation method of Fymat and Abhyankar. The nonlinear singular integral equations for the matrix functions K, L, K*, and L*, given by Sekera (1963), are solved by linearizing the equation for K. This linearized equation is written in an operator form, and its N-solution is given. After substitution of this solution in the equation for L, the resulting linear equation is also written in its operator form and its N-solution is obtained. The convergence of these series solutions is studied, and the regions of convergence in the case of a Rayleigh-scattering law are delimited when the solution for conservative Rayleigh scattering is taken as the reference. (auth)

19588 THEORY OF RADIATIVE TRANSFER IN INHOMOGENEOUS ATMOSPHERES. IV. APPLICATION OF THE MATRIX PERTURBATION METHOD TO A SEMI-INFINITE ATMOSPHERE. Abhyankar, K. D.; Fymat, A. L. (California Inst. of Tech., Pasadena). Astrophys. J.; 159: 1019-28(Mar 1970).

In order to describe the transfer of partially polarized radiation through an inhomogeneous semi-infinite atmosphere, a matrix N-function has been introduced by considering the limit of the K-function as the optical thickness of a finite atmosphere becomes infinite. The nonlinear singular integral equation satisfied by N is given; it generalizes the scalar H-equation of Sobolev for the fields in which the state of polarization must be taken into account. This equation is solved by the perturbation method in the form of a Neumann series. The region of convergence of this series solution is delimited for the Rayleigh law of scattering. An iteration scheme for computing the solution is described, and, as an illustration, sample computations are presented in which the N-functions for homogeneous Rayleigh nonconservative atmospheres with albedo for single scattering $\Omega = 0.25$ and 0.75 are derived from the N_0-function for a reference homogeneous atmosphere with $\Omega_0 = 0.5$. Comparison of these linear solutions with the exact solutions given earlier domonstrates the effectiveness of the matrix perturbation method; for example, the relative error in the reflected intensity is less than 0.2 percent for $\Omega = 0.25$ and less than 1.9 percent for $\Omega = 0.75$. (auth)

19589 SOLUTION OF A TIME-DEPENDENT EQUATION OF RADIATIVE TRANSFER. Code, Arthur D. (Univ. of Wisconsin, Madison). Astrophys. J.; 159: 1029-39(Mar 1970).

The time-dependent equation of radiative transfer for a plane-parallel isotropic scattering medium is solved in the first Gaussian approximation. The time dependence of the transmitted and reflected radiation is characterized by a time constant equal to $1/\kappa\rho c$. In any physical situation in which the intensity varies significantly during the time required for a photon to travel a unit optical depth, the time-dependent characteristics will be important. This is the case for novalike variables, novae, variable nebulae, and presumably quasi-stellar sources, among others. (auth)

19590 TIME-DEPENDENT RADIATION TRANSFER IN A SEMI-INFINITE ATMOSPHERE. Code, Arthur D. (Univ. of Wisconsin, Madison); Eason, George. Astrophys. J.; 159: 1041-6(Mar 1970).

The time-dependent equation of radiative transfer is treated in the first Gaussian approximation for the case of isotropic scattering. The equations are solved for a semi-infinite atmosphere by the method of Laplace transforms. The reflected radiation initially decays exponentially with time, with a time constant proportional to $1/\kappa\rho c$. The results provide an accurate solution for a specific time-dependent transfer problem that may be used to test other approximate treatments. (auth)

19591 STRUCTURE OF ENVELOPES EJECTED BY NOVAE. Mustel, E. R. (Astronomical Council, Moscow); Boyarchuk, A. A. Astrophys. Space Sci.; 6: 183-204(Feb 1970).

The paper contains an analysis of the structure of envelopes ejected during the outbursts of novae. The data used for this purpose were: (a) direct photographs of envelopes and the photographs taken with the use of different color filters; (b) spectra of envelopes. The envelope of DQ Her is studied most carefully. The analysis of all available data for the envelopes around DQ Her and V 603 Aql permits one to outline a morphological model of these envelopes. It appears, that the structure of both these envelopes is approximately identical and that the difference in the observed properties of the photographic images of the nebulae is connected with a difference in the orientation of the "polar" axes of the envelopes relative to the line of sight. The envelope ejected during the outburst of T Aur reveals the same properties, which are characteristic for the envelopes of DQ Her and V 603 Aql. From this it is concluded that the distribution of gases inside the envelopes of the majority of novae is approximately of the same character. This speaks in favor of the presence of certain forces around many novae, which guide the motion of ejected plasma along some quite definite directions inside rather small solid angles. It seems that the only conceivable forces of this type may be the forces of a magnetic nature. This hypothesis for example permits one to explain the difference between the envelope of GK Per and the envelopes of DQ Her, V 603 Aql, and T Aur. Comparing the velocity of expansion of the envelope of DQ Her and the rate of change of its angular size, it is computed that the distance to DQ Her is equal to 320 pc. On the base of photographs of the envelope of DQ Her it is found that in 1968 the flux $F_{H\alpha}$ of radiation in the Hα-line was equal to $(6 \pm 2) \times 10^{-12}$ ergs/cm^2 sec, whereas the mass of the envelope was equal to 10^{29} G and its electronic concentration n_e to 2×10^3 cm^{-3}. Several hypotheses, which may explain the stratification of emission from different elements inside the envelope, are discussed. (auth)

19592 STELLAR WIND FOR NONNEGLIGIBLE GRAVITATIONAL POTENTIAL OF THE ATMOSPHERE. Weidelt, Rolf D. (Univ., Wuerzburg, Ger.). Astrophys. Space Sci.; 6: 205-16(Feb 1970).

A spherically symmetric, isothermal and stationary stellar atmosphere is considered whose gravitational potential cannot be neglected. If κ, the ratio of the density on the base of the corona to the mean density of the star is not zero, the density vanishes at infinity for any solution of the hydrodynamic equations. The maximum mass loss depending on two dimensionless parameters, the ratio of the gravitational to the thermal energy, and κ are deduced. This mass loss has itself a maximum for $\kappa = 1/3$. (auth)

19593 MAXIMAL RED SHIFTS OF NEUTRON STARS. Kovetz, A. (Tel Aviv Univ., Israel). Astrophys. Space Sci.; 6: 293-6(Feb 1970).

It has been recently established that there exists a maximal red shift z_{max} for a homogeneous star of given mass M. The relationship $z_{max}(M)$ is obtained for neutron stars in the mass range $0.71 \leq M/M_{\odot} \leq 12.06$. (auth)

19594 STABILITY OF THE EQUILIBRIUM OF SUPERMASSIVE AND SUPERDENSE STARS. Calamai, Giulio (Osservatorio Astrofisico di Arcetri, Florence). Astrophys. Space Sci.; 6: 240-57(Feb 1970).

The second variation of the mass–energy (by constant baryon number) is analyzed to inquire into the stability of the equilibrium

for a spherical mass under the action of its own gravitation. The equations of general relativity are used. For zero density at the surface, the sphere is stable if (and only if) a solution of a second order equation (Jacobi equation) has "only" one zero in the interior (at center) of the sphere. The results obtained in this way coincide of course with those obtained by means of the Chandrasekhar–Misner–Zapolsky variational principle, but the solution of the Jacobi equation is more simple and straightforward. In particular, the stability of the several modes are analyzed without making any choice of a trial function for the Lagrangian displacement. The method is applied to the Gratton R-polytropic model of supermassive stars. (auth)

19595 GENERAL RELATIVISTIC ROTATIONAL PROPERTIES OF STELLAR MODELS. Cohen, Jeffrey M. (Goddard Space Flight Center, New York). Astrophys. Space Sci.; 6: 263-74(Feb 1970).

General relativistic expressions are given for the angular momentum and rotational kinetic energy of slowly rotating stars. These expressions contain contributions from the pressure, gravitational red shift, and Doppler shift, and the motion of inertial frames. These contributions are not negligible, e.g., there are stable neutron star models for which the angular velocity of inertial frames at the center is about 70% the angular velocity of the star. These expressions are useful in the study of pulsars if pulsars are rotating neutron stars. (auth)

19596 POTENTIAL ENERGY OF CONTINUOUS AND DISCRETE DISTRIBUTIONS OF MATTER FROM THE POINT OF VIEW OF THE APPLICATION OF THE VIRIAL THEOREM. Sher, D. (Louisiana State Univ., Baton Rouge). Astrophys. Space Sci.; 6: 275-86(Feb 1970).

The potential energy of clusters of stars in which the distribution of matter is taken to be continuous is compared with that of static model clusters in which the distribution of matter is discrete, the comparison being made from the point of view of applying the virial theorem to estimate the masses of the clusters. There is good agreement on the average between the two cases as long as the stellar distribution is random. Systematic differences occur whenever there is any departure from randomness. However, reduction of the mass of a cluster as estimated by means of the virial theorem by even as much as a factor of 2 on the average would seem to require even greater departures from randomness in the stellar distribution than are considered here. As might be expected there are sometimes very large fluctuations in the potential energy from one cluster to the next in the discrete case. (auth)

19597 NEUTRON STAR MODELS BASED ON AN IMPROVED EQUATION OF STATE. Cohen, Jeffrey M. (Goddard Inst. for Space Studies, New York); Langer, William D.; Rosen, Leonard C.; Cameron, A. G. W. Astrophys. Space Sci.; 6: 228-39(Feb 1970).

Using an equation of state for cold degenerate matter which takes nuclear forces and nuclear clustering into account, neutron star models are constructed. Stable models were obtained in the mass range above 0.065 $M_\odot$ and density range $10^{14.08}$ to $10^{15.4}$ gm/cm^3. All of these models were found to be bound. The outer crystalline layer of the star was found to have a thickness of 200 m or more depending on the mass of the model. (auth)

19598 HYPERONIC EQUATION OF STATE. Langer, William D. (Goddard Inst. for Space Studies, New York); Rosen, Leonard C. Astrophys. Space Sci.; 6: 217-27(Feb 1970).

An equation of state for cold matter at neutron star densities, $\rho > 10^{14}$ gm/cm^3, is evaluated. The gas is considered to be a degenerate mixture of neutrons, protons, leptons, hyperons, and massive baryons. The equilibrium equations including the effects of nuclear interactions among all the hadrons are derived. (auth)

19599 NARROW-BAND PHOTOMETRY OF G AND K STARS BETWEEN 3600 AND 6000 A. Morguleff, N.; Veron, M. P. (Institut d'Astrophysique et Observatoire, Paris). Astron. Astrophys.; 4: 391-403(Mar 1970). (In French).

By means of narrow-band photometry (photoelectric techniques), the classification (spectral type and luminosity class) of two hundred G and K stars, brighter than 8th magnitude, was studied. For the determination of the intensities in the bands centered on Na I, Mg I, Ca I, K of Ca II, CN lines, the method of Öhman was used and the measured intensities compared with the results obtained by other authors. An examination of three continuum relative values gives the red and blue gradients but they must be corrected for metallic line blanketing. Finally, the correlation is shown between some of the values and the fundamental parameters of classification. (auth)

19600 RADIAL VELOCITIES OF STARS IN THE REGION OF THE OPEN CLUSTER NGC 752. Rebeirot, E. (Observatoire, Marseille). Astron. Astrophys.; 4: 404-14(Mar 1970). (In French).

Radial velocities and spectral types were determined for 236 stars in the region of NGC 752 from plates taken with the Fehrenbach's objective prism of 40 cm. From the results, a mean radial velocity of +9 km s^{-1} and a true distance modulus of 7.75m were deduced for the cluster. The star's membership to the cluster is discussed. Ten stars are indicated as new probable members. The evolved F-type stars and K-type giants give a mean radial velocity faintly smaller than the mean value found for unevolved stars of the main sequence. (auth)

19601 THE ROTATIONAL TEMPERATURE OF A TiO BAND IN THE SPECTRUM OF R HYDRAE. Keller, Ch. F.; Jackson, B. V.; Poland, A. I.; Perry, B. F. Jr. (Indiana Univ., Bloomington). Astron. Astrophys.; 4: 415-18(Mar 1970).

A procedure is presented for the determination of a rotational temperature from observations of the (1.0) γ_3 TiO band. The method is based upon comparison between accurately measured wavelengths of blended absorption features in the band and corresponding wavelengths in the computed band profile. The rotational temperature found from McDonald coudé spectrograms of R Hydrae is $T_{rot} = 1430 \pm 290$°K. (auth)

19602 PHOTOELECTRIC OBSERVATIONS OF THE ULTRASHORT PERIOD VARIABLE DT VELORUM. Wisse, P. N. J. (Sterrewacht, Leiden). Astron. Astrophys.; 4: 419-22(Mar 1970).

Observations of the ultrashort-period RR Lyrae star DT Velorum are presented. V- and (V–B) curves and mean colors in the Walraven system are given. A suggestion is made about the interstellar reddening and absolute magnitude. The estimated distance is about 700 pc. (auth)

19603 SECULAR STABILITY OF UNIFORMLY ROTATING POLYTROPES. Tassoul, J.-L.; Ostriker, J. P. (Princeton Univ. Observatory, N. J.). Astron. Astrophys.; 4: 423-7(Mar 1970).

It is shown that uniformly rotating polytropes of index n less than 0.808 are secularly overstable, beyond the first bifurcation point on a given sequence, when viscosity is taken into account. In order to isolate the bifurcation point the lowest sectorial modes were calculated for various sequences. Secular stability for $n \gtrsim 0.8$ is due to the fact that for such polytropes, when constrained to rotate uniformly, $T/|W| \lesssim 0.14$ (T = kinetic energy, W = potential energy); whereas secular overstability appears only when $T/|W| > 0.14$, the latter critical value being almost independent of n. (auth)

19604 ON THE EVOLUTION OF CLOSE BINARY SYSTEMS WITH A TOTAL MASS 2.5 $M_\odot$. II. Giannone, P.; Refsdal, S.; Weigert, A. (Univ. of Nebraska, Lincoln). Astron. Astrophys.; 4: 428-36(Mar 1970).

For two close binary systems of total masses $M_1 + M_2 = 2.5\ M_\odot$, the evolution was calculated from the main sequence through the phase of mass exchange between the components. The systems start with the same mass ratios (1.1/1.4) but with different initial separations. The mass transfer begins after exhaustion of hydrogen in the central regions of the original primaries when they are evolving as red giants. After the mass exchange, these stars, in the order of increasing initial separations, become white dwarfs of 0.366 $M_\odot$ and 0.426 $M_\odot$. For the most massive remnant, the evolution was followed to the white dwarf stage. (auth)

19605 THE BINARY SYSTEM χ^2 HYDRAE = BV 722. Mauder, H. (Univ., Erlangen-Nuernberg, Ger.). Astron. Astrophys.; 4: 437-42(Mar 1970).

A radial velocity curve was obtained for the eclipsing binary χ^2 Hydrae = BV 722 = HD 96314. The pair consists of a B8 III–IV star of 5.2 solar masses and a B8.5 V star of 2.6 solar masses. The respective radii are 5.12 and 2.87 solar radii. The lines are relatively broad, from a tracing of Hγ it is seen that there is some influence of rotation. However, the equatorial rotational velocity of the primary component due to the bound rotation gives 135 km/s, which is well compatible with the observed broadening. (auth)

19606 FORCED OSCILLATIONS IN CLOSE BINARIES. THE ADIABATIC APPROXIMATION. Zahn, J. P. (Observatoire, Nice). Astron. Astrophys.; 4: 452-61(Mar 1970).

The forced oscillations of a star due to a periodic varying gravitational field are discussed. The following approximations are made: the star is not rotating and the oscillations are adiabatic and small enough to allow linearization. Olver's method is employed to derive a second-order asymptotic expression for the eigenfunctions. The results predict large amplitudes for the tides near the surface where, however, adiabaticity is a poor approximation. (auth)

19607 LIGHT-VARIATION OF HD 209813. Blanco, C.; Catalano, S. (Univ., Catania, Italy). Astron. Astrophys.; 4: 482-6(Mar 1970).

A new light curve in UBV is given for the spectroscopic binary HD 209813. It is shown that the light variation cannot be explained in terms of eclipse phenomena or tidal distortion. The photometric period found is different from the spectroscopic one determined by Northcott (1947) from radial velocity observations. (auth)

19608 ORBITS OF CHARGED BODIES. Sarvajna, D. K. (Univ. of Reading, Eng.). Astrophys. Space Sci.; 6: 258-62 (Feb 1970).

An investigation has been made into the possibility that material drawn out of a star goes into orbit around that star if electromagnetic effects are included. It is found that if the body has an initial charge of some 10^{37} esu, and decreasing with time, then sufficient angular momentum can be transferred to make orbits not intersecting the stellar surface possible. (auth)

19609 A STUDY OF HIGH-DISPERSION SPECTROGRAMS OF THE SHELL STAR ζ TAURI IN 1964 AND 1966. van der Wel, T. (Astronomical Inst., Utrecht). Astron. Astrophys.; 4: 341-56(Mar 1970).

Because of the lack of good models and good observations of the weak lines, the influence of diluted radiation on the line formation in shell stars has never been well understood. By means of very high-dispersion spectrograms of the shell star ζ Tauri obtained in 1964 and 1966 it has been possible to get a good set of line profiles and equivalent widths from lines of the Si II, Mg II, Ni II, and Fe II spectra. Dilution effects for Si II and Mg II are not evident. The shell was very active in 1964 and the line profiles, which are sharp on the red side, varied from day to day. The sharp cores of the hydrogen absorption lines were unusually deep, the emission region of Hα showed a strong absorption core. The He I lines behaved as expected in a rapidly rotating shell star. The Na D and Ca II resonance lines were much too strong for a B star. In spite of the difficulty of measuring the radial velocities of broad weak asymmetric lines it is found that the elements in the shell are not stratified. In 1964 the outer layers of the shell expanded less rapidly than the inner layers. In 1966 the shell spectrum was totally different from that in 1964. The shell lines were about half as strong as in 1964, the asymmetry was reversed and the outer layers expanded with respect to the inner layers. The cores of the Balmer lines were not so deep as in 1964 and there was a strong negative Balmer progression. The core of Hα had a strong positive velocity. Sharp unidentified emission lines are visible in the red region of the spectrum at 6320.1, 6386.0, and 6387.6 Å. ζ Tauri shows many points of resemblance with the shell star 48 Librae. (auth)

19610 DE-EXCITATION OF SINGLY IONIZED BARIUM IONS BY ELECTRON IMPACT. Davis, J.; Morin, S. (Ion Physics Corp., Burlington, Mass.). Astrophys. J.; 159: 1125-8(Mar 1970).

Calculations are presented for de-excitation cross-sections of singly ionized barium ions by electron impact over the energy range 0.5 to 30 eV. (auth)

19611 SPECTRAL CLASSIFICATION OF A AND F STARS. Barry, Don C. (Univ. of Arizona, Tucson). Astrophys. J., Suppl. Ser.; 19: No. 175, 281-304(Mar 1970).

The ultraviolet features in the 3300- to 4000-Å region of 117 Å mm^{-1} grating spectra of A and F stars are studied for the purpose of improving the relation between MK spectral type and b−y color. The Strömgren uvby system is used to define temperature sequences among dwarfs of similar line strengths. The temperature criteria are presented in tables showing the relative waxing and waning of ratios of spectral features as a function of spectral type. Luminosity criteria obtained from the ultraviolet spectra of the MK luminosity standards are tabulated for each 0.5 spectral type. A description is given of the differences in the ultraviolet spectra which correlate with differences in the Strömgren m_1 index for stars of similar spectral type and luminosity. More than 160 stars are classified according to temperature, luminosity, and line strength. The resulting relation between spectral type and color is an improvement over that of the MK standards and the Hyades main-sequence stars classified by Morgan and Hiltner. The new luminosity criteria permit the use of more luminosity subclasses than are possible with the standard MK criteria. Photometric methods for identifying Am and λ Bootis stars are suggested. While the photometry of spectroscopically identified weak-line F stars indicates low luminosity and low metallic-line strength, the photometry of the fast rotating spectroscopically identified weak-line A stars indicates luminosity slightly higher than normal and low metallic-line strength. Evidence is presented indicating the need for improvement in the definition of the Am stars. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

19612 PULSAR H-LINE ABSORPTION AND DISPERSION IN THE INTERSTELLAR MEDIUM. Manchester, R. N.; Murray, J. D.; Radhakrishnan, V. (CSIRO, Sydney). Astrophys. Lett.; 4: 229-32(Dec 1969).

Absorption measurements at λ21 cm were made on two Molonglo pulsars, PSR 0736−40 and PSR 0833−45, but distance limits cannot be placed for either pulsar from these measurements. Distance estimates from the dispersion measures are equally unreliable because of the heavy contribution to the dispersion from the Gum Nebula. (auth)

19613 SOURCES OF RADIATION WITH RELATIVISTIC STREAMING. Noerdlinger, Peter D. (New Mexico Inst. of Mining and Tech., Socorro, N. Mex.). Astrophys. Lett.; 4: 233-4(Dec 1969).

Sources of radiation like Woltjer's QSO model can exhibit apparent diameters far smaller than their true dimensions, and remarkably rapid time variations. (auth)

19614 H109alpha LINE OBSERVATIONS OF SIX PLANETARY NEBULAE, DR 21 AND IC 410. Terzian, Yervant; Balick, Bruce (Cornell Univ., Ithaca, N. Y.). Astrophys. Lett.; 4: 195-8(Dec 1969).

Hydrogen 109α recombination line observations were made on six planetary nebulae, and on the H II regions DR 21 and IC 410. The recombination lines from planetary nebulae have not been detected. In particular previous observations of the line detection from NGC 7027 have not been confirmed. DR 21 and IC 410 show well defined lines. (auth)

19615 DISTANCES OF THE GALACTIC H II REGIONS NGC 3576 AND 3603. Goss, W. M.; Radhakrishnan, V. (CSIRO, Sydney). Astrophys. Lett.; 4: 199-203(Dec 1969).

A comparison was made of H126α velocities, OH velocities, and H I absorption velocities in the direction of the two prominent optical nebulae in Carina, NGC 3576 and 3603. Both objects are beyond the tangential point in this direction (3.6 kpc). The evidence suggests that NGC 3603 is at ~8.4 kpc while NGC 3576 is just beyond the tangential point. NGC 3603 is one of the most distant optically visible H II regions in the Galaxy. Its intrinsic properties are quite similar to those of W49A. (auth)

19616 THE STRUCTURE OF 3C 9. Clark, B. G. (National Radio Astronomy Observatory, Green Bank, Va.); Miley, G. K. Astrophys. Lett.; 4: 207-10(Dec 1969).

The structure of the quasar 3C 9 was measured at 408 MHz and 2695 MHz. The source is double with components whose spectral indices differ by 0.4. Morphologically, it resembles 3C 47. (auth)

19617 THE SPECTRUM AND ANGULAR STRUCTURE OF 3C 273 AT LOW FREQUENCIES. Bell, S. J.; Hewish, A. (Cambridge Univ., Eng.). Astrophys. Lett.; 4: 211-13(Dec 1969).

Observations of interplanetary scintillation show that 3C 273 contains two components possessing angular diameters of ~0.2 arc sec and ~2 arc sec at meter wavelengths. The compact source has a flux density which rises sharply at low frequencies. (auth)

19618 CROSS SECTIONS FOR THE EXCITATION OF HIGHLY EXCITED HYDROGEN ATOMS BY ELECTRONS AND PROTONS. Percival, I. C.; Richards, D. (Univ. of Stirling, Scotland). Astrophys. Lett.; 4: 235-7(Dec 1969).

Accurate cross sections for some important processes involving highly excited hydrogen that occur in the H II region are obtained in analytic form. The cross sections are needed for the theory of radio recombination lines. (auth)

19619 INFRARED CONTINUUM OF NONTHERMAL SOURCES. Kleinmann, Douglas Erwin. Houston, Tex.; Rice Univ. (1969). 194p.

Thesis.

Infrared observations of diverse nonthermal sources, including the Crab Nebula, the jet in M 87, and the Seyfert Galaxies were made and analyzed. The Crab Nebula data include the longest infrared wavelength measurement made to date. The fit of the 1.55μ data on the optical jet of M 87 to the extrapolation of the radio core spectrum indicates that the usual presumption of identifying the one with the other is correct. Observations of the nonstellar continuum emanating from the nuclear regions of the Seyfert Galaxies have shown these objects to be superluminous, infrared galaxies. (TSS) (Diss. Abstr. Int., B)

19620 PROCESSES LEADING TO DEVIATIONS OF SPECTRA OF DISCRETE SOURCES OF COSMIC RADIATION FROM

THE POWER LAW. Braude, S. Ya.; Zhuk, I. N.; Lebedeva, O. M.; Men, A. V.; Ryabov, B. P. (Inst. of Radiophysics and Electronics, Kharkov). Ukr. Fiz. Zh.; 14: 1761-85(Nov 1969). (In Russian).

The relation is considered between a spectrum type of discrete radio sources in the decametric range and physical processes occurring in the sources and medium between the object of radiation and observer. Three kinds of phenomena are analyzed: (1) a turndown of a low-frequency spectrum of synchrotron radiation caused by absorption in H II, by reabsorption and the fact that the medium refractive index is less than one; (2) distortions of a low-frequency spectrum due to the difference of the particles energetic spectrum from the power law; (3) deviations from a linear spectrum caused by the action of the acceleration mechanism in shock waves by coherent synchrotron radiation and collective oscillations of plasma. Typical peculiarities of low-frequency spectra are considered in the presence of various mechanisms of radiation and absorption of radio waves. It is supposed that together with the main mechanism, i.e., synchrotron radiation, in quasars and supernovae remnants other radiation mechanisms might act associated with the interaction of plasma waves with relativistic electrons, maser effect, coherent plasma radiation, photon acceleration due to their merging with plasmons, etc. The influence of the mechanism of relativistic electron acceleration in shock waves on a radiation spectrum is considered, and the possibility of formation of a steep energetic spectrum of particles that causes a strong radiation increase at low frequencies is shown. (auth)

19621 PULSARS–NEUTRON STARS. Biermann, Ludwig (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Umsch. Wiss. Tech., 69: 480-1(July 17, 1969). (In German).

A new species of astronomic objects became known in 1968 with the discovery of pulsars. It appears that at least a part of them are neutron stars whose mass density must be of the order of the density in the atomic nucleus which is about 100 to 1000 billion times the density of ordinary matter. Since its mass must correspond somewhat to that of the Sun (mean density of 1.4 g/cm^3), this means a radius which must be smaller by a factor of 50,000 to 100,000, that is roughly about 10 km. The state of such matter has been predicted, but is still not known empirically. (tr-auth)

19622 TECHNIQUES FOR PULSAR OBSERVATION. Ellis, G. R. A. (Univ. of Tasmania, Hobart, Australia). Proc. Astron. Soc. Aust.; 1: 289-90(Sep 1969).

Specifications are forwarded for two general-purpose transit radiotelescopes, one of frequency range 6 to 60 MHz and one of range 88 to 500 MHz. (Australia)

19623 HIGH-RESOLUTION OBSERVATIONS AT 408 AND 5000 MHz OF A REGION NEAR l^{II} = 312°. Shaver, P. A. (Univ. of Sydney); Goss, W. M. Proc. Astron. Soc. Aust.; 1: 280-2(Sep 1969).

High-resolution maps of 72 regions in the galactic plane were obtained and the spectral indices of over 200 discrete sources were derived. One of the regions is considered in detail in this preliminary analysis. (Australia)

19624 RADIO OBSERVATIONS OF INTERSTELLAR FORMALDEHYDE. Whiteoak, J. B.; Gardner, F. F. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Proc. Astron. Soc. Aust.; 1: 282-3(Sep 1969).

The preliminary results of an investigation of the $1_{11}-1_{10}$ transition of formaldehyde, carried out with the Parkes 210-ft reflector, are reported. (Australia)

19625 FIFTEEN MONTHS OF PULSAR ASTRONOMY. Radhakrishnan, V. (Commonwealth Scientific and Industrial Research Organization, Epping, Australia). Proc. Astron. Soc. Aust.; 1: 254-63(Sep 1969).

Research on pulsars since their discovery is reviewed. The characteristics of pulsars discovered to date are compared in tables. The galactic distribution, distance, and amplitude variations are discussed, as well as existing pulsar theories, with particular reference to the Vela and Crab pulsars. (Australia)

19626 DECREASE IN THE HIGH-ENERGY X-RAY FLUX FROM CENTAURUS XR-2. Lewin, W. H. G.; McClintock, J. E.; Smith, W. B. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 159: L193-6(Mar 1970).

On 1969 March 20 balloon x-ray observations (>20 keV) were carried out from Mildura, Australia. No evidence was found for x-ray emission from Cen XR-2. This means that the energy flux from Cen XR-2 in the range 20 to 100 keV has decreased to a level at least 7 times below the one observed by Lewin, Clark and Smith on October 15, 1967. (auth)

19627 OBSERVATIONS OF THE $^2\Pi_{\frac{1}{2}}$, J = ½ STATE OF INTERSTELLAR OH. Zuckerman, B. (Univ. of Maryland, College Park); Palmer, Patrick. Astrophys. J.; 159: L197-201(Mar 1970).

The 140-foot telescope of the National Radio Astronomy Observatory was used to study 6-cm A-doublet radiation from the $^2\Pi_{\frac{1}{2}}$, J = ½ state of interstellar OH. The presence of an F = 1 → 0 transition in the source W49 was confirmed, and additional features in the source W3 were detected. The degree of polarization of these lines is low. (auth)

19628 ABSORPTION LINES IN QUASI-STELLAR OBJECTS. Burbidge, E. M.; Burbidge, G. R. (Univ. of California, San Diego). Astrophys. J.; 159: L185-6(Mar 1970).

Four of the QSOs listed by Bahcall as being in the fields of comparatively nearby clusters of galaxies and, therefore, as being worth searching for intergalactic absorption lines in their spectra, have already been noted as having absorptions, but in all cases absorption redshifts are much larger than the cluster redshifts and are likely to arise in the objects. New observations of two of the QSOs are described. (auth)

19629 ACTIVITY IN THE CRAB NEBULA FOLLOWING THE PULSAR SPIN-UP OF 1969 SEPTEMBER. Scargle, Jeffrey D.; Harlan, E. A. (Lick Observatory, Santa Cruz, Calif.). Astrophys. J.; 159: L143-6(Mar 1970).

The wisps near the center of the Crab have undergone definite changes which appear to have originated near the pulsar at the time of its recent spin-up. The amount of energy liberated in this activity (between 10^{41} and 10^{45} ergs) suggests that the event was more than a simple internal change of the neutron star. (auth)

19630 HIGH-FREQUENCY-RESOLUTION STUDIES OF H I, OH, AND CH_2O ABSORPTION SPECTRA IN SAGITTARIUS A. Sandqvist, Aa. (Univ. of Maryland, College Park). Astron. J.; 75: 135-40 (Mar 1970).

Absorption profiles towards Sgr A have been observed in the 1420-, 1667-, and 4830-MHz lines of H I, OH, and CH_2O with velocity resolutions of 1.67, 1.42, and 0.49 km/sec, respectively. The 0-, –50-, and +45-km/sec H I absorption features and the +40- and –130-km/sec OH absorption features were also observed with higher velocity resolutions ranging from 0.42 to 0.10 km/sec. The +40-km/sec absorption features are very broad and smooth with only slight structure, supporting the picture of rotation of the cloud of origin as a uniform body. This compact cloud, near the galactic center, has a high relative abundance of molecules such as OH, CH_2O, and NH_3, and also contains H I but no detectable H_2O. The NH_3 emission is concentrated towards one side of the cloud. The H I profile contains a local feature at +5.8 km/sec, and a flat shoulder from +3.5 to –6.5 km/sec coming from the Sagittarius and Norma–Scutum spiral arms, which also have a higher relative abundance of molecules than the local arm. The –130-km/sec absorption feature seen in OH is not detectable in CH_2O, an effect due to the smaller beam used in the CH_2O observations. Distinct asymmetry is present in the absorption feature due to the 3-kpc arm. (auth)

19631 MEASUREMENT OF 21-CM LINE CALIBRATION REGIONS. Penzias, A. A. (Bell Telephone Labs., Inc., Holmdel, N. J.); Wilson, R. W.; Encrenaz, P. J. Astron. J.; 75: 141-3 (Mar 1970).

The integrated 21-cm line radiation from four calibration regions was measured. From these measurements it is concluded that the temperature scale of the corrected Maryland–Green Bank survey is 2% low. (auth)

19632 SURVEY OF THE SOUTH CELESTIAL POLAR REGION AT 408 MHz. Price, Richard M. (Massachusetts Inst. of Tech., Cambridge). Astron. J.; 75: 144-8(Mar 1970).

A survey of the region within 15° of the south celestial pole at a frequency of 408 MHz is compared with a source survey at 1410 MHz to show the contribution of discrete sources to the over-all brightness distribution in such a medium-latitude region. Smoothing the 408-MHz survey and comparing it with the absolute brightness temperature at the south celestial pole as measured with a large horn antenna at the same frequency yields the absolute base level for the region. (auth)

19633 A SURVEY OF THE SKY AT 610.5 MHz. III. THE REGION BETWEEN Dec. +22° AND +27°. Wendker, H. J.; Dickel, J. R.; Yang, K. S. (Univ. of Illinois, Urbana). Astron. J.; 75: 148-57(Mar 1970).

The third section of the catalog of radio sources being made with the 400-ft radio telescope at the Vermilion River Observatory of the University of Illinois has been completed. The declination range is +22 to +27°; approximately 7.3% of this region has been omitted to avoid sidelobe confusion. All sources are tabulated whose 610.5-MHz flux densities are greater than 0.8 f.u. Spectral indices are also given for the sources. (auth)

19634 DETECTION OF 166a RECOMBINATION-LINE RADIATION IN THE DIRECTION OF THE GALACTIC CENTER. Riegel, Kurt W.; Kilston, Steven D. (Univ. of California, Los Angeles). Astrophys. J.; 159: L155-7(Mar 1970).

166a recombination-line emission from the direction of the galactic center, Sgr A, has been detected with the 140-foot telescope of the National Radio Astronomy Observatory. The peak antenna temperature was 0.14°K. If the line is due to hydrogen, the radial velocity is 6.6 km sec^{-1} with respect to the local standard of rest, and the full width at half-maximum power is 28 km sec^{-1}. The emission line may originate in the continuum source or in the interstellar medium between the Sun and the galactic center. (auth)

19635 STATISTICS OF QUASI-STELLAR OBJECTS. Dobrovol'skii, O. V. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 12: No. 9, 16-20(1969). (In Russian).

Statistical data were used for determining the distribution of 105 quasars, with known redshifts, in the celestial sphere. (R.V.J.)

19636 PULSARS. Hewish, A. Fiz. Szemle; 19: 265-9 (Sep 1969). (In Hungarian).

Toward the end of 1967 the author and his collaborators discovered radioastronomic radiation sources which emit systematically repeated strong pulses. These so-called pulsars are assumed to be neutron stars. Their existence has been predicted theoretically; they are so small that they can be detected only by highly sensitive radiotelescopes. By Jan. 1969 locations of more than two dozen pulsars had been determined. The fine structure of the emitted flashes was carefully studied and the time-frequency correlations have been partially clarified by now. The changes in the frequency spectrum are assumed to reflect changes within the source itself. Assuming that the density of the interstellar gas is 0.1 electron cm^{-3}, the pulsars are quite close —between 100 and 1500 parsec, with respect to the dimensions of the Galaxy which is assumed to be 20,000 parsec. On the other hand, calculations based on the 21-cm emission of H atoms indicated a distance of more than 4000 parsec. Models advanced by various authors to explain the observed phenomena are mentioned. Clarification of this mechanism is expected to help to explain the behavior of extremely heavy matter. (TTT)

19637 INFRARED LINE EMISSION FROM H II REGIONS. Petrosian, Vahe (California Inst. of Tech., Pasadena). Astrophys. J.; 159: Pt. 1, 833-46(Mar 1970).

Formulae are given relating the infrared line intensities to radio and optical fluxes of H II regions. The line intensities expected from the Orion Nebula are calculated. With present techniques a number of fine-structure lines and only a few infrared recombination lines of hydrogen could be detected. The observations of the infrared fine-structure lines and the forbidden-line intensities of p^2 and p^4 ions can be used for simultaneous determination of electron temperature and density. The fine-structure lines from p and p^5 ions are the best means of measuring the abundances of these ions. The ratios of infrared to optical recombination-line intensities could be used to determine the interstellar absorption. (auth)

19638 RADIOASTRONOMY FROM SPACE. Stone, R. G. (Goddard Space Flight Center, Greenbelt, Md.). Sci. J.; 6: No. 3, 68-75(Mar 1970).

Conventional radioastronomy is limited in frequency by the absorption of the atmosphere, which prevents long wavelengths from reaching the ground. Results from the first radio telescope in space are good, and point the way to giant radio telescopes in orbit or on the Moon by 1980. (auth) (UK)

19639 LONG-TERM VARIATIONS OF PULSAR INTENSITIES. Cole, T. W.; Hesse, H. K.; Page, C. G. (Cavendish Lab., Cambridge, Eng.). Nature (London); 225: 712-13(21 Feb 1970).

Pulsar intensity variations may be divided roughly into three classes. Firstly, there are rapid variations, on a time scale of seconds to minutes, which occur simultaneously over a wide frequency range and must therefore be intrinsic to the source. Secondly, on a somewhat longer time scale there are variations, typically over a few minutes to a few hours, which correlate only over limited bandwidths; there is strong evidence that these are caused by irregular diffraction in the interstellar medium. Thirdly, there are variations on a time scale of days to months about which little is known. Some new results obtained during timing observations carried out on a routine basis over 11 months are reported. The pulsars observed were CP 0808, 0834, 0950, 1133, and 1919 and observations were made during meridian transit with the 81.5 MHz phase array at Cambridge. Results are shown graphically. All five pulsars showed similar behavior in that variations on time scales extending from a few days to several weeks were clearly evident. CP 0950 appeared to be the most variable source, with the greatest fluctuations. Comparisons are made with data at 408 MHz. It is stated that there seems to be no possibility of accounting for long-term intensity variations by random diffraction in the interstellar medium. Since the scintillation mechanism seems inappropriate, and since there is a possible correlation over wide frequency ranges, it may be concluded that the long-term variations are intrinsic to the source, but there do not seem to be many processes in a neutron star that would lead to variations on so long a time scale; simultaneous observations at different frequencies may provide further clues. It may be noted that large increases of intensity that persist for a few weeks might give rise to associated variations of period large enough to be observable. (UK)

19640 LOW-ENERGY GAMMA RADIATION FROM CYGNUS. Haymes, R. C.; Harnden, F. R. Jr. (Rice Univ., Houston, Tex.). Astrophys. J.; 159: 1111-14(Mar 1970).

The low-energy γ-ray spectrum of Cyg XR-1 and XR-3 was remeasured in a balloon flight launched June 4, 1969, the measurement employed the same instrumentation as that used 21 months earlier. No change in the spectrum at energies between 34 and 567 keV was detected. The power-law energy spectrum steepens by approximately one power between 100 and 150 keV. (auth)

19641 CAN DISCRETE SOURCES PRODUCE THE COSMIC MICROWAVE RADIATION? Smith, M. G.; Partridge, R. B. (Princeton Univ., N. J.). Astrophys. J.; 159: Pt. 1, 737-43 (Mar 1970).

After making a few general assumptions about the properties of discrete microwave sources, the amount of fluctuation the sources will produce in measurements of the temperature of the cosmic microwave background is calculated. By comparing these results with the available observations, it is shown that, if discrete sources produce the microwave background, then either the number of microwave sources per Mpc^3 must exceed the number of galaxies or the deceleration parameter must be less than 0.1. The effect on the observable temperature fluctuations of scattering by an intergalactic plasma is taken into account. (auth)

19642 POSSIBLE NONEQUILIBRIUM NATURE OF COSMIC-BACKGROUND RADIATION. Alexanian, Moorad (Univ. of California, Livermore). Astrophys. J.; 159: 745-52(Mar 1970).

A general result in quantum statistical mechanics allows one to determine, from the observed photon spectrum, whether the cosmic-background radiation is due to a primeval fireball or arises from a superposition of spectra from discrete extragalactic sources. Also, an upper bound to photon spectra is used as a criterion for establishing whether the shorter wavelengths of a photon spectrum can possibly be due to the same entity as that giving rise to the longer wavelengths. (auth)

19643 ISOTROPIZATION OF ELECTRONS IN SYNCHROTRON SOURCES. Melrose, Donald B. (Univ. of Maryland, College Park). Astrophys. Space Sci.; 6: 321-37(Feb 1970).

Electrons radiating synchrotron radiation develop a pitch-angle anisotropy, and so become unstable to the coherent emission of hydromagnetic waves. The evolution of the coupled system of anisotropic electrons and waves is studied in the absence of any dissipation of the waves in the ambient medium. The anisotropy of the electrons approaches a steady state in which the anisotropy is energy independent and of order v_A/c (v_A = Alfvén speed). The conditions for this small degree of anisotropy to be maintained are examined. Due to this scattering the bend in the synchrotron spectrum, from an inverse power law with index α to one with index $\frac{4}{3}\alpha + 1$, due to an initial or recurrent injection of electrons, could only occur at infrared or higher frequencies. (auth)

19644 EFFECT OF INTERSTELLAR DENSITY FLUCTUATIONS ON SIGNAL DISPERSION MEASURE. Lerche, I. (Univ. of Chicago). Astrophys. Space Sci.; 6: 287-92(Feb 1970).

The effect of electron number density fluctuations in the interstellar medium on signals from pulsars is studied in terms of the frequency dependent signal dispersion. It is shown that if the density fluctuations are representative of long wavelength ($1 \sim 100$ pc) [or large scale length ($1 \sim 100$ pc)] disturbances in the interstellar gas, then the observed signal dispersion is not a measure of the integral of the electron number density in the line of sight. Evidence has been presented elsewhere for believing that such long wavelength disturbances should exist in the interstellar gas, so this result indicated that some care must be exercised in the interpretation of signal dispersion measurements from pulsars. (auth)

19645 ON THE QUESTION OF THE DISTANCE TO THE GALACTIC RADIO SOURCE W 31. Wilson, T. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 4: 487-8(Mar 1970).

On the basis of OH, H I, and formaldehyde absorption spectra,

it is concluded that the galactic radio source W 31 is more than 2.4 kpc from the Sun, the near kinematic distance estimated from the H109α recombination line radial velocity. (auth)

19646 A SURVEY OF H 109 α RECOMBINATION LINE EMISSION IN GALACTIC H II REGIONS OF THE NORTHERN SKY. Reifenstein III, E. C. (Massachusetts Inst. of Tech., Cambridge); Wilson, T. L.; Burke, B. F.; Mezger, P. G.; Altenhoff, W. J. Astron. Astrophys.; 4: 357-77(Mar 1970).

A survey of hydrogen 109α recombination lines was carried out during 1967 using the 140-foot telescope of the National Radio Astronomy Observatory. One hundred and twenty galactic sources were observed, and hydrogen recombination line emission was detected in a total of 82 of the sources in the survey. Recombination lines corresponding to heavier elements were measured for six of the stronger sources. The helium and hydrogen profiles for M17 and Orion A indicate a number density ratio of helium to hydrogen of 0.08, corresponding to a helium mass fraction of 0.26. An unexpectedly large fraction, roughly one-third of the sources studied, exhibited no recombination line, although their distribution in longitude is similar to that of normal H II regions. (auth)

19647 THE CYGNUS X REGION. VI. A NEW 2695 MHz CONTINUUM SURVEY. Wendker, H. J. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 4: 378-86 (Mar 1970).

A 2695-MHz continuum survey of the Cygnus X region was undertaken with the NRAO 140-ft telescope with an angular resolution of 11′. A reference frame was established relative to which all intensities were measured. The improved positional accuracy helped to identify the resolved sources more accurately with optical features than had been possible before. In most cases, the deviations between centers of radio and optical emission of the H II regions are too large to be explained by positional inaccuracy. The lack of known distances of the H II regions in this area allows only their emission measures to be derived. From a comparison between radio and Hα emission the visual absorption is estimated in a few cases. For IC 1318a, a pair of possibly exciting stars is suggested. (auth)

19648 MOTION OF NEUTRAL HYDROGEN IN CONNECTION WITH THE ASSOCIATION II (ξ) PER. Sancisi, R. (Sterrenkundig Laboratorium Kapteyn, Groningen, Netherlands). Astron. Astrophys.; 4: 387-90(Mar 1970).

Observations of the 21-cm hydrogen emission line in the Perseus region were made with the 25-meter radiotelescope at Dwingeloo. In the direction of the association of O and B stars II Per the radial velocity of the neutral hydrogen referred to the local standard of rest reaches a maximum value of +8 km/s, which is a few km/s higher than the velocity in the surroundings. The average radial velocity of the stars of the association is about +15 km/s, referred to the local standard of rest. (auth)

Solar Phenomena

Refer also to abstracts 19790 and 19813.

19649 SOME FLARE-SENSITIVE HIGH PHOTOSPHERIC AND LOW CHROMOSPHERIC LINES. Oehman, Yngve. Solar Phys.; 10: 178-83(Nov 1969).

An attempt was made to find an influence of flare radiation on the high photospheric and low chromospheric lines of the area occupied by the flare. Observations were made in the Hα region and in the region of the H and K lines. When flare emission is present in sunspots, some of the faint (molecular) lines seem to be weakened. When a flare appears near the solar limb some of the Evershed-type (chromospheric) lines are strongly influenced. (auth)

19650 PLASMA WAVE PROPAGATION IN THE NEIGHBORHOOD OF A MAGNETIC NEUTRAL POINT. Harkness, Richard L. Jr. (Harvard Coll. Observatory, Cambridge, Mass.). Solar Phys.; 10: 154-67(Nov 1969).

A linearized magnetohydrodynamic formalism is used to examine the propagation in two dimensions of transverse waves in a plasma in which is embedded a curl-free magnetic field. Only waves of frequency less than the ion cyclotron frequency are considered. The behavior of a wave packet near the magnetic neutral point is deduced from the general solution to the problem, which is found in terms of Bessel functions whose order is frequency-dependent. It is shown that a disturbance propagates through the medium with a group velocity that decreases from the speed of light at large distances from the neutral point to zero at the neutral point, and that the amplitudes of the velocities associated with the disturbance diverge there. It is suggested that the "stagnation" of waves near the origin and the deformation of the magnetic field resulting from the large plasma-flow velocities may provide a clue to the formation of the magnetic neutral sheet required by several flare theories and a theory of the acceleration of cosmic rays. (auth)

19651 SOME MORPHOLOGICAL PARTICULARITIES OF THE SOLAR CORONA ON 22 SEPTEMBER 1968. Koutchmy, S. (Institut d'Astrophysique, Paris). Astrophys. Lett.; 4: 215-20 (Dec 1969).

Three coronal streamers of different kinds are considered. None of these streamers seems to have developed autonomously. The magnetostatic model not being able to account for this, closer connections with the solar activity are suggested. (auth)

19652 ULTRAVIOLET WAVELENGTHS AND OSCILLATOR STRENGTHS FOR 3d–nf TRANSITIONS IN THE HELIUM ISOELECTRONIC SEQUENCE. Brown, Robert T. (EG and G, Inc., Las Vegas, Nev.). Astrophys. J.; 158: 829-37(Nov 1969).

Accurate variational wave functions and energies were obtained for the 4^1F, 5^1F, 6^1F, 4^3F, 5^3F, and 6^3F states of the helium isoelectronic sequence through Z = 16. The trial functions are eighteen-term configuration-interaction expansions in members of a denumerably complete basis set (Sturmian functions). These have been used with previously calculated 3^1D and 3^3D wave functions to obtain wavelengths and oscillator strengths for 3d–nf transitions. For He I and Li II, the only species in which these transitions have been observed, the calculated energies agree with observations to within 0.000002 atomic unit. The discrepancy between calculated and observed wavelengths is in the worst case one part in 4700 and is generally much smaller. For higher members of the sequence, the predicted wavelengths range from 2077 Å for Be III to 48 Å for S XV. Oscillator strengths were calculated by means of the dipole length, velocity, and acceleration formulae, and agreement among the three values is in most cases to within 2%. (auth)

19653 FREQUENCY SPLITTING OF TRANSIENT SOLAR RADIO BURSTS. Ellis, G. R. A. (Univ. of Tasmania, Hobart, Australia). Proc. Astron. Soc. Aust.; 1: 273-4(Sep 1969).

A comparison is made of the variation of gyrofrequency with solar radius computed from split-pair bursts and type-II bursts. (Australia)

19654 STREAMING OF SOLAR COSMIC RAYS. McCracken, K. G.; Palmer, I. D. (Univ. of Adelaide). Proc. Astron. Soc. Aust.; 1: 276-8(Sep 1969).

A 13-day study at low energy (0.7 to 7.6 MeV) of the anisotropy of solar cosmic rays, is analyzed. Recordings were made by a solid-state detector on the geocentric IMP-F satellite. Data are fitted to three drifts in the ecliptic. (Australia)

19655 DYNAMIC SPECTRA OF 4 TO 2 MHZ SOLAR BURSTS: RESULTS FROM ORBITING GEOPHYSICAL OBSERVATORY III. Graedel, Thomas Eldon. Ann Arbor, Mich.; Univ. of Michigan (1969). 216p.

Thesis.

During the period June 7, 1966 to September 30, 1967 the OGO-III experiment detected 218 solar radio bursts in the 4- to 2-MHz passband, of which 96% were confirmed by higher-frequency observations. The frequency drift rate of the bursts ranged from 0.05 to 0.20 MHz/sec, the average being 0.095 ± 0.010 MHz/sec. Burst durations ranged from 20.9 seconds at 4 MHz to 25.6 seconds at 2 MHz. The range in flux densities at 3.5 MHz was 1 to 110×10^{-17} watt m^{-2} Hz^{-1}. Type V continuum radiation followed the fast drift burst in at least 2% of all cases. No evidence for slow-drift (Type II) bursts was found. Correlation of optical flare and solar radio burst observations permitted association of about three-fourths of the radio bursts with specific solar flares and, hence, with solar plage regions. There is only a moderate relationship between the importance of a flare and its ability to produce a low-frequency solar burst. Eight plage regions were associated with 54% of all 4- to 2-MHz bursts observed. These regions were very large, had major sunspots, and were extremely flare-rich. Three of the regions produced significant numbers of solar radio bursts on two successive rotations. It appears that a significant change in a sunspot group or a filament may be connected with a temporary increase in low-frequency radio burst production from a plage region. The growth and development of fast drift bursts were studied as a function of the burst emission bandwidth, the electron injection time scale, and the local coronal temperature. This appears to be the first attempt to study the combined effects of these factors on the development of radio bursts, and has permitted a consistent derivation of their values. They are: bandwidth of emission centered on the plasma frequency, 650 ± 250 kHz; time scale of electron injection into the emitting region, 10 to 20 seconds; and temperature of the 3.5-MHz emitting region, 160,000 to 450,000°K. This range of temperatures can be accounted for by a change of a factor of five

between different streamer density profiles, while maintaining a constant temperature function with radial distance. (TSS)(Diss. Abstr.)

19656 SOLNTSE I IONOSFERA. KOROTKOVOLNOVOE IZLUCHENIE SOLNTSA I EGO VOZDEISTVIE NA IONOSFERU. (Sun and Ionosphere. Short-Wave Solar Radiation and Its Effects on the Ionosphere). Ivanov-Kholodnyi, G. S.; Nikol'skii, G. M. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1969). 456p.

Data are given on the nature of solar uv and x radiation, ionosphere physics, and short-wave solar radiation collected by means of rockets and satellites. Short wave spectra $\lambda < 1215$ Å were used for determining the relative chemical abundances on the Sun. A model of active and nonperturbed solar atmosphere regions including the transitional area between the chromosphere and corona is described. A table with more than 1000 lines in the short-wave solar spectrum with the anticipated radiation flux in them and a list of 450 correlated lines observed in the spectrum are included. The influence of short-wave solar radiation on the ionization in the upper atmosphere was analyzed. The generalized theory of simple layers is discussed and the distribution of various ions in the D, E, F_1, and F_2 layers and their variations during the day and with the solar activity was calculated. Up-to-date concepts on photochemical theory, ionization processes, ion–molecule reactions in the ionosphere, the role of ambipolar diffusion and variations of effective coefficients of recombination are discussed. The theory of ionosphere formation was correlated with the measurements carried out with rockets and satellites and earth–atmosphere observations. 810 references. (R.V.J.)

19657 DYNAMO THEORY OF STELLAR AND PLANETARY MAGNETIC FIELDS. I. CALCULATION OF SUN-LIKE ALTERNATING FIELD GENERATORS. Steenbeck, M.; Krause, F. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Astron. Nachr.; 291: No. 2, 49-84(1969). (In German).

A dynamo theory is developed for stellar and planetary magnetic fields based on a nonmirror-symmetrical turbulent motion in an electrically conducting fluid providing for an average electromotive force parallel to the average magnetic field. This effect can lead to a self-excited buildup of magnetic fields by dynamo action. Since, owing to the action of Coriolis forces, turbulent motions in rotating systems are generally nonmirror-symmetrical, it becomes possible to explain stellar and planetary magnetic fields. The basic equations, which form a system of partial differential equations, are treated by a separation method. The results give evidence of the possibility of MHD alternating field dynamos. Furthermore, the magnitude of the calculated eigenvalues and the similarities between the calculated field and the observed solar magnetic field show that the sun realizes a dynamo of this kind. (IAA)

19658 INTERPLANETARY SHOCK WAVES. I. GROSS STRUCTURE. Sonett, C. P. (Ames Research Center, Moffett Field, Calif.). Comments Astrophys. Space Phys.; 1: 178-85 (Sep-Oct 1969).

Remarks are presented which are intended to be very preliminary and concerned only with the large-scale structure and evolution of shocks. The hope is that the bulk description can eventually lead to a connection between the shock-system structure and the flare or m-region solar input as well as understanding of the overall geometry and fate of the material inserted into the solar wind. (W.D.M.)

19659 ANISOTROPIC ATOMIC HYDROGEN DISTRIBUTION IN INTERPLANETARY SPACE. Chambers, W. H.; Fehlau, P. E.; Fuller, J. C.; Kunz, W. E. (Los Alamos Scientific Lab., N. Mex.). Nature (London); 225: 713-14(21 Feb 1970).

Modifications of current theories concerning the interaction of the solar wind with interstellar hydrogen were suggested by Blum and Fahr (Nature 223: 937 (1969)), including provision for the motion of the solar system. This motion, coupled with the velocity of the interstellar hydrogen, results in a velocity of 10 to 40 km/sec for interstellar hydrogen relative to the solar system, and this relative velocity gives rise to an anisotropic distribution of neutral H atoms in interplanetary space. The neutral hydrogen density is enhanced in the direction of approach of the interstellar hydrogen and diminished in the opposite hemisphere, and the motion of the interstellar hydrogen is assumed to cause a highly aspherical transition region between the hydrogen and the solar wind. Observations with satellite-borne detectors of Lyman-α radiation are described that appear to support, qualitatively, the model of Blum and Fahr. Measurements were made with ion chambers on two Vela 4 spacecraft launched on April 28, 1967. (UK)

19660 REVISED ABSOLUTE f-VALUES FOR λ 3247 OF NEUTRAL COPPER AND λ 3720 OF NEUTRAL IRON. Bell, Graydon D.; Tubbs, Eldred F. (Harvey Mudd Coll., Claremont, Calif.). Astrophys. J.; 159: Pt. 1, 1093-1100(Mar 1970).

Recent atomic-beam measurements of absolute f-values for the resonance lines of neutral copper and iron yield values which are about 30% higher than atomic-beam values reported in the past. The new values are 0.43 for λ3247 of Cu I and 0.041 for λ3720 of Fe I. In the case of copper, the new value is in excellent agreement with recent measurements of lifetimes. In the case of iron, some discrepancies between results obtained by different investigations still exist. Nevertheless, the need for a 0.1-dex reduction in the Corliss and Tech absolute scale of log gf-values for iron is indicated. (auth)

19661 SURFACE ALBEDO AND THE FILLING-IN OF FRAUNHOFER LINES IN THE DAY SKY. Hunten, Donald M. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 159: 1107-10(Mar 1970).

The observed partial filling-in (Ring effect) of solar lines in light from the sky has been explained by Brinkmann as due to rotational Raman scattering. Analogous effects in the albedo contribution are examined, and are shown to be capable of accounting for a variation with solar zenith angle, and for the marked variability that is observed. The principal effect responsible for smearing of the spectrum is probably the so-called Rayleigh wings, which can be regarded as heavily damped rotational Raman scattering in condensed matter. (auth)

19662 NEW CLASSIFICATION FOR Gd II SOLAR LINES. Spector, Nissan (Soreq Nuclear Research Center, Yavne, Israel). Astrophys. J.; 159: Pt. 1, 1091-2(Mar 1970).

The recent discovery of a new system of energy levels of singly ionized gadolinium obtained by adding an outer electron to the $4f^8$ core permitted completion of the classification of all Gd II lines observed in the solar spectrum. (auth)

19663 OBSERVATIONS OF THE BRIGHTNESS AND POLARIZATION OF THE OUTER CORONA DURING THE 1966 NOVEMBER 12 TOTAL ECLIPSE OF THE SUN. Pepin, T. J. (Univ. of Minnesota, Minneapolis). Astrophys. J.; 159: 1067-75 (Mar 1970).

Photographs of the solar corona from a camera flown on the NASA CV-990 at an altitude of 40,000 feet were obtained on November 12, 1966. The absolute brightness, polarization, and direction of polarization of the solar corona between 3.5 and 13 $R_\odot$ were determined from these photographs. A significant polarized component was found in this region, the structure of which can be closely correlated with features in the inner corona. Comparisons are made in the July 20, 1963 and May 30, 1965 eclipses, and evidence is given for changes in brightness of the coronal light between these eclipses. (auth)

19664 INTERPLANETARY GAS. XV. NONRADIAL PLASMA MOTIONS FROM THE ORIENTATIONS OF IONIC COMET TAILS. Brandt, John C.; Heise, John (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 159: 1057-66(Mar 1970).

Orientations of Type I comet tails show a dispersion apparently attributable to effects of waves and/or discontinuities in the interplanetary medium. The mean azimuthal plasma velocity is calculated with an improved analysis, and a value of about 9 km sec^{-1} is derived, which confirms Brandt's result; in addition, the azimuthal velocity is found to increase with increasing geomagnetic activity. These results allow a computation of the total loss rate of angular momentum from the Sun, and an e-folding time of 3 to 4×10^9 years is found for a constant solar wind. The initial Sun could have had a much higher equatorial rotational velocity, in agreement with Kraft's results, if the flux of the solar wind has a comparable time scale. (auth)

19665 A NEW DESCRIPTION OF THE GADOLINIUM SPECTRA IN THE PHOTOGRAPHIC INFRARED. Spector, Nissan; Held, S. (Soreq Nuclear Research Center, Yavne, Israel). Astrophys. J.; 159: 1079-90(Mar 1970).

The gadolinium spectra excited by electrodeless discharge and a dc arc in air were observed in the wavelength region 7300 to 12300 Å. About 950 lines were measured, with an uncertainty of ±0.015 Å. Assignments of the lines to Gd I or Gd II are given for about 900 lines. (auth)

19666 ON THE EXISTENCE OF A PURELY RADIATIVE TEMPERATURE RISE IN THE SOLAR CHROMOSPHERE. Skumanich, A. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 159: 1077-8(Mar 1970).

The approximations implicit in Cayrel's statistical-equilibrium or non-LTE analysis of the H-bound–free continuum in the Sun are examined and are shown to be consistent and independent of any assumption regarding the nature of the energy equilibrium. It is

also shown that Jordan's contention that radiative equilibrium imposes a constraint on the non-LTE state of H^- and thus removes any non-LTE temperature rise in the solar chromosphere is in error. (auth)

19667 THE PERSISTENCE OF THE SOLAR AND GEOMAGNETIC ACTIVITY. PART 2. Cehak, K.; Pichler, H. (Zentralanstalt fuer Meteorologie und Geodynamik, Vienna). Arch. Meteorol., Geophys. Bioklimatol., Ser. A; 18: 365-76(1969). (In German).

The persistence of the daily values of some parameters of the solar and geomagnetic activity, which were used in the first report of this series (wherein the variance spectrum analysis method was used) was studied. The autocorrelation function and the variance spectra of the Zurich relative sunspot numbers and of the 10.7-cm radiation flux from the sun were again very similar; however, the values of the autocorrelation function of the 10.7-cm flux were larger than those of the sunspot numbers at the same lag. They show only one significant wave with a period of about 27 days, which is related to the rotation of the sun. This wave vanishes during the years of the sunspot extremes and in 1965, when the solar activity was nearly equally distributed over the entire rotation of the sun, it is entirely random. The geomagnetic parameters (A_p and ΣK_p indices) showed autocorrelation functions and variance spectra with a number of waves with periods smaller than 27 days besides the one with 27 days. The period of the wave with the largest amplitude was smallest in the years of the sunspot extremes but it increased in the years between these extremes to a maximum and then decreased again. The structure of the flare index showed a trend like the other solar parameter, as well as some smaller waves like the geomagnetic parameter, which again indicated a correlation between the flares and the geomagnetic indices. (BBB)

Galaxies

Refer also to abstract 19783.

19668 INTRINSIC DISPERSION IN THE DIMENSIONS OF CLUSTERS OF GALAXIES AND THE ANGULAR DIAMETER–REDSHIFT RELATION. Peach, J. V.; Beard, J. M. C. (Oxford Univ.). Astrophys. Lett.; 4: 205-6(Dec 1969).

An estimate of the intrinsic dispersion in the diameters of rich clusters of galaxies indicates that the use of the angular diameter–redshift relation applied to rich clusters is a practicable method of determining the deceleration parameter, comparable in precision with the redshift–magnitude relation applied to brightest cluster members. (auth)

19669 ELECTRON TEMPERATURE DISTRIBUTIONS AND INTERNAL KINEMATICS OF SEVEN DIFFUSE NEBULAE. Foukal, Peter (Univ. of Manchester, Eng.). Astrophys. Space Sci.; 5: 469-92(Dec 1969).

A Fabry–Pérot spectrophotometer was used to derive values of the intensity ratio Hα/[N II] at 98 points in the seven bright diffuse nebulae M8, M20, M16, M17, NGC7000, M42, IC434. The fraction of nitrogen in the singly ionized state was estimated in the different objects, and was found to be sufficiently constant within any one nebula so that the above intensity ratio may be used to derive accurate electron temperature distributions. The position of the peak of the nebular line, its excess nonthermal width, its shape and relative intensity were used to derive kinematical models of these objects. It was found that values of Hα/[N II] ≃ I are representative of the bright central cores of these nebulae. Temperatures between 7000°K and 12000°K were derived in the different objects. Although some of this apparent variation is due to the different conditions of excitation in the various nebulae, it is shown that a convincing progression of temperature in M8, M16, M17 is supported by radio recombination line results. The temperature variation within any one object was generally significantly less than 1500°K. No evidence was found for velocities of mass motion at more than twice the speed of sound. Relative radial velocities of generally less than 15 km sec^{-1} characterized the velocity fields of M8, M20, M16, and M42. The velocities in M17 were measured as about 20 km sec^{-1}. Motions in NGC7000 and IC 434 were much lower (~5 km sec^{-1}) although here the number of points taken was too small to construct meaningful kinematical models. It is concluded that the internal motions of radiatively ionized H II regions of Pop. I will not significantly affect the results of existing surveys for determining the rotation of the Galaxy with radial velocities deduced from nebular emission lines. (auth)

19670 THE GAMMA-RAY EMISSION FROM THE GALACTIC CENTER AND THE ORIGIN OF GALACTIC COSMIC-RAY ELECTRONS. Longair, M. S. (Cambridge Univ., Eng.); Sunyaev, R. A. Astrophys. Lett.; 4: 191-3(Dec 1969).

It is suggested that the intense γ-ray source observed in the direction of the galactic center may be the result of inverse Compton scattering of the photons of the intense infrared source at the galactic center. The total energy released from the galactic center (~10^{40} erg/sec) would be sufficient to supply the total radio background from the Galaxy and the break in the cosmic-ray electron spectrum would be naturally explained. The model has important consequences for the diffusion of cosmic-ray electrons in the Galaxy. (auth)

19671 REFLECTION NEBULAE AND THE NATURE OF INTERSTELLAR GRAINS. Vanysek, Vladimir (Charles Univ., Prague). Vistas Astron.; 11: 189-216(1969).

The results of recent studies on reflection nebulae are discussed. An accurate photoelectric method, applied to measurements of brightness, color, and polarization of galactic nebulae, can now be used for the exploration of the physical nature of interstellar grains. The fitting of several theoretical models of interstellar grain-clouds to the observed color distributions in bright reflection nebulae shows that the presence of dielectric grains in such objects is more probable than the presence of small particles with other physical properties. (auth)

19672 ORIGIN OF EMISSION LINES IN OPTICAL SPECTRA OF RADIOGALACTIC NUCLEI. Melik-Alaverdyan, Yu. K. (Byurakan Astrophysical Observatory, Erevan). Dokl. Akad. Nauk Arm. SSR; 48: 277-9(1969). (In Russian).

An attempt was made to determine the origin of the emission lines in the spectra of galactic nuclei and the energy of radioactive decay. It was assumed that the considerable amount of radioactive material formed in galactic nuclei during the moment of the radio outburst was responsible for the subsequent nuclear activity. Calculations were made of the amount of radioactive material necessary to induce the excitation and ionization of the gas in the nuclei. (R.V.J.)

19673 EMISSION LINES IN THE OPTICAL SPECTRA OF RADIOGALACTIC NUCLEI. Melik-Alaverdyan, Yu. K. (Byurakanskii Astrophysical Observatory, Erevan). Dokl. Akad. Nauk Arm. SSR; 48: 212-14(1969). (In Russian).

Radiogalactic nuclei emit intensive lines of hydrogen and forbidden lines of a series of other elements. The recombination time of the emitting gas is substantially less than the age of the radiogalaxy, as calculations have showed. Hence, some mechanism of ionizing and exciting the gas in a radiogalaxy must continue to exert its effect, although it is not understood what would be the origin of the energy exciting the optical emission. A radio-emitting cloud is thrown from a galactic nucleus at 0.1 to 1.0 times the speed of light. Hence if the distance r of the center of the radio source from radiogalactic nucleus is known, the age of the radio galaxy can be roughly estimated as τ (age) = r/0.5 c. The distance r is related to the radio magnitude M_r as follows: $M_r < 5.25 \lg r - 35.5$. Here r is expressed in kiloparseconds. Thus the age τ is less than τ_0, where τ_0 is determined by the above relations: $\tau_0 = 4.1 \times 10^{10} \cdot 10^{M_r/5.25}$ years. Hence if the maximum intensity of the optical emission of a radiogalaxy is determined, it is also possible to determine the dependence of τ_0 on the optical emission. The log of the absolute intensity of the emission lines is correlated with definite values of the absolute radiomagnitude M_r. (TTT)

19674 TWO DOUBLE GALAXY SYSTEMS. Lewis, B. M. (Australian National Univ., Canberra). Proc. Astron. Soc. Aust.; 1: 288-9(Sep 1969).

Arguments are forwarded for the association of NGC 247 to NGC 253 and for NGC 5236 to NGC 5253. (Australia)

19675 FAR-INFRARED OBSERVATIONS OF THE GALACTIC CENTER. Aumann, H. H. (Rice Univ., Houston, Tex.); Low, F. J. Astrophys. J.; 159: L159-64(Mar 1970).

The center of the Galaxy was observed between 40 and 350 μ. The measured peak flux of $(8 \pm 3) \times 10^{-21}$ W m^{-2} Hz^{-1} at $(4.2 \pm .2) \times 10^{12}$ Hz corresponds to a total integrated infrared flux at the Earth of $(2.8 \pm 1.0) \times 10^{-5}$ erg sec^{-1} cm^{-2}. If a distance of 10^4 pc is assumed, the total infrared luminosity of the galactic nucleus is $(8 \pm 3) \times 10^7$ $L_\odot$. The far-infrared diameter of the nucleus is less than 3′ (10 pc), and its position agrees to within 6′ with the position of Sag A. Size and luminosity considerations strongly favor a nonthermal model of the galactic nucleus which consists of multiple sources. A number of discrete sources with flux levels of about 1.5×10^{-21} W m^{-2} Hz^{-1} were found near the galactic nucleus. (auth)

19676 OBSERVATIONS OF INFRARED GALAXIES. Kleinmann, D. E. (Rice Univ., Houston, Tex.); Low, F. J. Astrophys. J.; 159: L165-72(Mar 1970).

Infrared flux densities have been measured over the last 5 years for a number of galaxies. The continuum out to 25 μ, the existence

of large variations, and estimates of total infrared luminosities are presented. (auth)

19677 INFRARED-GALAXY PHENOMENON. Low, Frank J. (Rice Univ., Houston, Tex. Univ. of Arizona, Tucson). Astrophys. J.; 159: L173-7(Mar 1970).

An ensemble of identical infrared sources, called irtrons, radiates the quiescent infrared continuum now found to characterize the nuclei of all galaxies. Continuous creation of matter and antimatter within the irtrons releases energies greater than 10^{62} ergs. The observed infrared continuum results from coherent synchrotron decay of electrons and positrons produced by annihilation. The observed infrared luminosities form an evolutionary sequence beginning with QSOs, extending to Seyfert galaxies and exploding galaxies, and ending with large spirals like our own. (auth)

19678 DISSOLUTION OF EARLY CLUSTERS OF GALAXIES BY STRONG QUASI-STELLAR SOURCES. Noerdlinger, Peter D. (New Mexico Inst. of Mining and Tech., Socorro). Astrophys. J.; 159: L179-83(Mar 1970).

All galaxies may once have been in compact clusters with diameters of ~0.4 Mpc, gravitationally bound by much uncondensed gas. In almost all cases, the gas was driven out by the expanding radio halos of QSSs which formed in the clusters, and these fell apart and yielded the field galaxies. The most massive clusters remained bound, but they expanded, and comprise the clusters we see today. The epoch of dissolution and expansion must have run from large redshift ($z \sim 10$) to redshift $\lesssim 2$, with some straggling thereafter. This model would account for the excess QSO absorption spectra at large redshift, the production of S0 galaxies by the Spitzer–Baade mechanism of collision, the similarity between field and cluster galaxies, and the presence of small groups of interacting galaxies. It would allow (desirably) galaxies to condense after the clusters, and it favors the present anticorrelation of QSOs with clusters of galaxies. Predictions can be made on the velocity dispersion of field galaxies. (auth)

19679 CHANGES IN THE NUCLEAR SPECTRUM OF THE SEYFERT GALAXY NGC 4151. Cromwell, R. (Optical Sciences Center, Tucson, Ariz. Steward Observatory, Tucson, Ariz.); Weymann, R. Astrophys. J.; 159: L147-9(Mar 1970).

Evidence is presented that the violet-displaced absorption lines of hydrogen discovered by Anderson and Kraft in the nucleus of NGC 4151 are transient features with a time scale of 1 year. This evidence is used to reassess the rate of mass ejection by Anderson and Kraft. (auth)

19680 IMPROVED PHOTOGRAPHS OF THE NGC 1275 PHENOMENON. Lynds, R. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J.; 159: L151-4(Mar 1970).

New Hα interference-filter photographs of the radio galaxy NGC 1275 are described and illustrated. These photographs show the spectacular extent of the distribution of outlying material in the system and place new limits on the presence of material having velocities differing from those previously known. The character of the distribution of material strongly supports the explosive interpretation of the NGC 1275 phenomenon. (auth)

19681 A 21-CM STUDY OF THE SPIRAL GALAXY MESSIER 33. Gordon, Kurtiss Jay. Ann Arbor, Mich.; Univ. of Michigan (1969). 103p.

Thesis.

The distribution of neutral atomic hydrogen and the kinematic properties of the late-type spiral galaxy M33 are derived from observations obtained at 21-cm wavelength with a multichannel radiometer attached to the 300-foot paraboloidal transit telescope of the National Radio Astronomy Observatory. The effective half-power beam and band widths of the telescope system are 10:0 in δ, 11:4 in α, and 21 km/sec in radial velocity. The assumed distance to M33 is 720 kpc. The galaxy contains $\mathcal{M}_{HI} = 1.6 \times 10^9\ \mathcal{M}_\odot$ of neutral hydrogen distributed in a broad ring of radius 18′ plus an underlying uniform distribution of radius ~35′ and two outlying "wings" or companions. The companions contain ~10% of the total hydrogen content. The center of the H I ring and of the distributions of H II regions and luminous stars in M33 are offset by a few minutes of arc from the optical center of the galaxy. The systemic radial velocity is S = −180 km/sec (heliocentric). The rotation curve peaks at $V_r = S \pm$ ~85 km/sec, 30′ from the galactic center. For an inclination of 55°, this leads to a total mass of $\mathcal{M}_t = 4.9 \times 10^{10}\ \mathcal{M}_\odot$, of which $2.3 \times 10^{10}\ \mathcal{M}_\odot$ is contained within 60′ of the center (roughly the extent of the observations). An asymmetry of the rotation curves for the two halves of the major axis leads to a mass ratio of $\mathcal{M}_N/\mathcal{M}_S = 1.2$. Noncircular motions are small in the main body of the galaxy. Velocities in the wings deviate by 40 to 50 km/sec from those predicted by the rotation curve. The data are consistent with a picture of the wings as stable gaseous companions of M33, gravitationally bound to the galaxy but not physically connected to the galactic plane. The global parameters of M33: $\mathcal{M}_{HI}/\mathcal{M}_t = 0.03$, $\mathcal{M}_{HI}/L_\odot = 0.34$, and $\mathcal{M}_t/L_\odot = 10.4$ (solar units), are not significantly different from average values of the corresponding parameters for galaxies of similar structural type. A search for a bridge of neutral hydrogen between M31 and M33 yields an upper limit of $N_{HI} \leq 5 \times 10^{14}$ cm^{-2} in the region between the galaxies. This limit is roughly ¼ of the observed surface density in the bridge between NGC 4631 and NGC 4656 and ¼ of the observed density in the bridge between the Magellanic Clouds. The model-fitting technique described and used in this study has been shown to be a powerful tool for studying the kinematics and hydrogen distribution of galaxies. (Diss. Abstr.)

19682 AN UPPER LIMIT TO THE ABUNDANCE OF ^{3}He II IN MESSIER 17. Seling, Theodore Victor. Ann Arbor, Mich.; Univ. of Michigan (1969). 57p.

Thesis.

An attempt has been made to detect the emission from the hyperfine transition line of singly-ionized ^{3}He, or ^{3}HeII, in M 17. Observational results establish a limit to the number abundance of ^{3}He = $(3.7 \pm 5.5) \times 10^{-5}$ of the hydrogen abundance. This limit is approximately two orders of magnitude lower than that established by observations of the λ10830 Å line of neutral helium in the Orion Nebula. The upper limit established here corresponds to the presently used primeval abundance of ^{3}He = 3×10^{-4} of the ^{4}He abundance obtained from meteorites. This would indicate that there has been no significant production of ^{3}He to the present time. The instrumentation used in the measurement was specially designed for the experiment. A parametric amplifier cooled in a liquid-nitrogen bath was used as a preamplifier for the receiver to obtain a low system-noise temperature. The receiver local oscillator was set to center the emission line in a narrow-band (500 kHz) receiver IF channel. Two similar channels spaced ± 900 kHz from the line frequency were used as comparison channels to reduce the effects of gain fluctuations. The observations and the data reduction were also designed to minimize the effects of gain fluctuations and systematic errors. Observations were also made of the H91α recombination line in M 17 as an overall check of the observing technique and equipment. A ratio of the line-to-continuum temperature of (10 ± 1)% was established. These results are consistent with measurements of the hydrogen recombination lines made at lower frequencies. (Diss. Abstr.)

19683 GALACTIC HALO. Truran, J. W.; Cameron, A. G. W. (Yeshiva Univ., New York. Goddard Inst. for Space Studies, New York). Nature (London); 225: 710-11(21 Feb 1970).

The galactic halo is a nearly spherical region containing very old stars having a smaller content of heavy elements than the Sun. There is no detailed model for its formation, but it is usually assumed that somehow a cloud of gas condensed to form the Galaxy and that the halo stars were formed during the collapse process and left with a nearly spherical distribution. In that case, and in view of the theories of nucleosynthesis, it is puzzling that the halo stars should possess any heavy elements. This problem was reconsidered by the authors. The approach was that of following the chemical history of the Galaxy by integrating the effects of stellar evolution, and the principal arguments and conclusions reached are stated. The assumptions about stellar evolution were heavily influenced by recent studies of supernova explosions. It was found that the heavy element content of the Galaxy rose quickly in the first 2×10^9 years, but subsequently increased only slowly, and that most stars have a heavy element content within a factor of three of the solar content. It was concluded that in the early history of the Galaxy almost all the stars formed were more massive than the Sun, which is consistent with current ideas about star formation. The analysis indicated that in the original stellar birth-rate function about 5% of the mass ended up in "collapsars" or "black holes" (Schwarzschild singularities), but with revised birth-rate assumptions the "collapsar" mass fraction becomes about an order of magnitude lower, leading to some interesting suggestions, which are summarized. The calculations indicate that about half the present mass of the Galaxy is in the form of "collapsars", which is not in conflict with observational evidence and, it would be expected that the Galaxy would be nearly twice as massive as usually assumed, with most of the extra mass distributed throughout the halo. It has been puzzling that giant elliptical galaxies have such a high mass-to-light ratio; the present consideration lead to the suggestion that most of the mass of such galaxies is in the form of "collapsars." (UK)

19684 RATES OF STELLAR COLLISIONS IN THE NUCLEUS OF NGC 4151. Sanders, Robert H. (Princeton Univ., N. J.). Astrophys. J.; 159: 1115-18(Mar 1970).

Upper and lower limits on the mass of the source of continuous radiation in the nucleus of NGC 4151 are determined from obser-

vations by Oke and Sargent. If the upper limit of 5 pc on the radius of the source of continuum radiation measured during a recent flight of Stratoscope II is utilized and if it is assumed that this central object is a stellar system, then rates of stellar collisions of one collision every 1.4 years and every 20 years, respectively, are determined for the two mass limits. If the actual radius is taken to be about 0.5 pc, stellar collisions in this system leading to disruption of stars could account for the observed luminosity and light fluctuations of the nucleus of NGC 4151. (auth)

19685 THE ABUNDANCE RATIO OF HELIUM TO HYDROGEN IN EXTRAGALACTIC NEBULAE. Peimbert, Manuel (Univ., Mexico, Mexico City); Spinrod, Hyron. Astrophys. J.; 159: 809-15 (Mar 1970).

From photoelectric measures of emission lines the $N(He^+)/N(H^+)$ abundance ratios are obtained for NGC 604, NGC 4449, NGC 5461, NGC 5471, and NGC 7679. An estimate, based on forbidden-line intensities, is made of the degree of ionization as well as the amount of neutral helium inside the H II regions. The derived N(He)/N(H) values are equal to 0.10 with the exception of NGC 604 for which the value is 0.13. The results are compared with previous determinations of abundance ratios of helium to hydrogen. Upper limits for the helium abundances in M51 and M81 are presented. (auth)

19686 THE SPECTRA AND REDSHIFTS OF THIRTY MARKARIAN GALAXIES WITH ULTRAVIOLET CONTINUA. Sargent, Wallace L. W. (Mount Wilson Observatory, Pasadena, Calif.). Astrophys. J.; 159: 765-72(Mar 1970).

Redshifts were determined from 190 Å mm^{-1} image-tube spectrograms for thirty of the seventy galaxies with ultraviolet continua discovered by Markarian. These thirty do not constitute a random sample of the Markarian galaxies. The redshifts, corrected to the galactic center, range from 918 to 22,869 km sec^{-1}; the absolute magnitudes lie in the range $-21.5 < M_p < -14.7$ with a mean value of $\langle M_p \rangle = -19.6$. Twenty-six of the thirty galaxies have emission-line spectra, and five of these also have absorption lines. There are two new galaxies (Markarian 50 and Markarian 69), with Seyfert-like spectra composed of broad Balmer emission lines with sharper forbidden lines. The other twenty-four emission-line objects have sharp lines with a half-width less than 300 km sec^{-1}. Their range of excitation is similar to galactic H II regions. It is tentatively concluded that these sharp-emission-line objects are excited by hot stars; however, most of them are probably not Type I irregular galaxies at large distances. The galaxies with ultraviolet continua have at least one-thirtieth the space density of normal galaxies. (auth)

19687 ON THE HYPOTHESIS THAT THE COMA CLUSTER IS STABILIZED BY A MASSIVE, IONIZED INTERGALATIC GAS. Turnrose, Barry E.; Rood, Herbert J. (Wesleyan Univ., Middletown, Conn.). Astrophys. J.; 159: 773-89(Mar 1970).

The possibility that a massive, ionized intergalactic gas stabilizes the Coma cluster is investigated. Analysis of the physical processes in such a gas shows the existence of serious restrictions on the model: Hβ and x-ray data limit the temperature to the range 10^4 to $10^{8.5}$K, substantial heating mechanisms are required to maintain that temperature over the age of the cluster, and some way of preventing collapse of the gas is needed: as long as $T \lesssim 10^{8.5}$K, kinetic pressure cannot balance self-gravitation. Consideration of various possible heating and supportive mechanisms indicates that none are adequate (with the possible exception of effects of a highly turbulent intercluster medium), so that the ionized-gas model appears to be physically implausible. (auth)

19688 SPECTRAL LINES AND RADIAL VELOCITIES OF GALAXIES IN PAIRS. Page, Thornton (Wesleyan Univ., Middletown, Conn.). Astrophys. J.; 159: 791-7(Mar 1970).

Measures of the spectra of eighty-eight galaxies in forty-five close pairs have been reviewed and corrected. Originally measured for velocity differences used in a determination of the average masses of galaxies, they are now listed in conventional form, together with twenty-six independent measures by others. Evidence is noted for a possible systematic difference in redshift between emission and absorption lines. (auth)

19689 NONCIRCULAR GAS MOTIONS IN NGC 253: EVIDENCE FOR OUTFLOW FROM THE CENTER. Demoulin, M. H.; Burbidge, E. M. (Univ. of California, San Diego). Astrophys. J.; 159: 799-807(Mar 1970).

The velocity field in the ionized gas in the central regions of NGC 253 has been analyzed with the Lick 120-inch telescope. Noncircular motions found earlier by Burbidge et. al. have been confirmed. Within 7 to 10′ of the center, strong emission lines give an approach velocity of 120 km sec^{-1} relative to the systemic velocity. The outflow velocity decreases in directions off the minor axis. Emission lines are still strong southeast of the center in a bright fan-shaped area. In these regions, the electron temperature is higher than in spiral-arm regions and turbulent velocities are ~150 km sec^{-1}. Various models for the velocity flow are discussed. The most probable interpretation is that the outflow was produced by a violent event in the center that gave rise to the nonthermal radio emission of NGC 253; in this model, a cone or column of gas moves out from the center at an angle between the equator and rotation axis, in a manner similar to H I gas flow in the center of our Galaxy. On the near side, the inner dusty spiral arm has a residual outflow of some 40 km sec^{-1} relative to the systemic velocity. (auth)

19690 STABILITY OF THE SYSTEM OF STARS, GAS, AND MAGNETIC FIELDS. Nimi, Hideyuki (Kyoto Univ.). Astrophys. Space Sci.; 6: 297-314(Feb 1970).

Linear stability of a system of stars, gas, and magnetic fields under the existence of a relative motion between the stars and the gas is investigated by the use of the magnetohydrodynamic and the polytropic equations for the gas and the collisionless Boltzmann equation for the stars together with the Poisson equation. The star system is supposed to have the anisotropic Schwarzschild distribution. The critical wave number is calculated and it is found that the system becomes universally unstable under some conditions. (auth)

19691 EQUIVALENT WIDTHS AND OPTIMUM REGIONS OF SPACE FOR THE DETECTION OF INTERSTELLAR H_2. Cartwright, D. C.; Drapatz, S. (Max-Planck-Institut fuer Extraterrestrische Physik, Munich). Astron. Astrophys.; 4: 443-51(Mar 1970).

The equivalent widths for the rotational lines from $J'' = 0.1$ of the Lyman and Werner bands of H_2 originating from $v'' = 0$ were calculated for kinetic temperatures of 10 and 100°K, and H_2 column densities from 10^{+11} to 10^{+18} cm^{-2}. The oscillator strengths used for the Lyman bands were the recent results of Allison and Dalgarno while those used for the Werner bands were calculated in the Franck–Condon approximation, including the effects of Λ doubling. From examination of data on the character and location of dust clouds and uv stars, a number of dust clouds with bright background stars that are promising candidates for the detection of absorption by H_2 were determined. Those H_2 absorption lines that are least likely to be obscured by other spectral lines are given as determined by comparison with recent rocket uv spectra from typical background stars. (auth)

19692 EVIDENCE FOR A POSSIBLE EXPULSION OF GAS FROM THE GALACTIC NUCLEUS. van der Kruit, P. C. (Sterrewacht, Leiden). Astron. Astrophys.; 4: 462-81(Mar 1970).

A survey of the high-velocity part of the 21-cm profiles of neutral hydrogen was made in a region between $l = 350°$ and $l = 10°$ and between $b = -5°$ and $b = +5°$. Features not associated with the structure in the plane are all found at velocities that would be forbidden according to galactic rotation. At negative longitudes they are situated above the galactic plane, at positive longitudes below it. The observations suggest an ejection of clouds from the nucleus in two roughly opposite directions at a large angle with the plane, which may be identical with that of the secondary ridge of continuum radiation found by Kerr and Sinclair. The total hydrogen mass involved is at least 10^6 $M_\odot$. Similarities with the motions in the nuclei of Seyfert galaxies indicate that a number of explosive events may have caused the expulsion of these clouds. (auth)

Cosmology

19693 POSSIBILITY OF FORMATION OF DOUBLE SYSTEMS IN THE GENERAL RELATIVITY. Abramowicz, Marek. Postepy Astron.; 17: 387-95(Dec 1969). (In Polish).

A singular solution to the Kepler problem in general relativity is applied to the theory of double system formation. (auth)

19694 GRAVITATIONAL WAVES: THE EVIDENCE MOUNTS. Wick, Gerald L. Science; 167: 1237-9(27 Feb 1970).

A brief summary is presented of Weber's work on the detection of gravitational waves and some other work on the mass loss of galaxies which seems to corroborate Weber's hypothesis is mentioned. (W.D.M.)

19695 CASE FOR A HIERARCHICAL COSMOLOGY. de Vaucouleurs, G. (Univ. of Texas, Austin). Science; 167: 1203-13 (27 Feb 1970).

It is maintained that the time has come to give serious consideration to hierarchical models either within the framework of otherwise conventional relativistic cosmology, if that is possible, or

within the context of the steady-state theory, which is eminently compatible with the kinds of large-scale properties discussed. Topics discussed include some historical perspective, questionable assumptions of orthodox cosmology, clustering and superclustering over 10 to 100 million light years, higher-order clustering over 100 to 1000 million light years, definition of a mean space density, density–radius relation and Carpenter's density restriction, cosmological implications, and Charlier's hierarchical models, and cosmology in a clumpy Universe. (W.D.M.)

19696 INSTABILITY OF A ROTATING UNIVERSE. Silk, Joseph (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 13-19(1970).

It is shown that the Gödel Universe, in which there is a uniform rotation relative to the local compass of inertia, is stable to perturbations in the plane of rotation, but unstable to density perturbations along the rotation axis. The qualitative aspects of this result may be applicable to a more realistic Universe with expansion provided that there is nonzero rotation and the Universe is always matter-dominated. (auth)

19697 PRODUCTION OF THE DIFFUSE BACKGROUND X-RAY FLUX AT 44 A BY SUPRATHERMAL PROTON BREMSSTRAHLUNG. Brown, Robert L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 159: L187-92(Mar 1970).

It is shown that the excess of soft x-rays observed at 44 Å can be interpreted as bremsstrahlung emission from collisions of suprathermal protons with an ambient distribution of electrons. Three models are constructed in which the demodulated spectrum of cosmic-ray protons is assumed confined to the Metagalaxy, to the Local Group, and to the galactic halo; x-ray production by the bremsstrahlung interaction of this proton flux with the electrons residing in the respective media is discussed. It is concluded that present observations cannot distinguish between these models and ones presented previously based on free–free emission in a hot, dense intergalactic plasma. (auth)

19698 THE DETERMINATION OF THE DECELERATION PARAMETER AND THE COSMOLOGICAL CONSTANT FROM THE REDSHIFT-MAGNITUDE RELATION. Peach, J. V. (Mount Wilson Observatory, Pasadena, Calif.). Astrophys. J.; 159: 753-63(Mar 1970).

Sandage's photoelectric photometry of brightest cluster galaxies is used with published photometry by Baum for a redetermination of the deceleration parameter q_0 in cosmological models both with and without a cosmological constant Λ. It is found that the observations are adequate only for setting upper and lower bounds on this constant, $+2 \times 10^{-55} \geq \Lambda \geq -2 \times 10^{-55}$ cm^{-2}. Solutions for q_0 have been computed for a number of combinations of the data and are given. For Λ = 0, the thirty-eight galaxies of Sandage with $z \lesssim 0.2$ give $q_0 = 0.6 \pm 0.4$ (p.e.); combined with Baum's data, they give $q_0 = 1.5 \pm 0.4$ (p.e.). An evolutionary correction of $M_{,t} = 0.00 \pm 0.05$ mag per 10^9 years increases the uncertainty and gives $q_0 = 1.5 \pm 0.9$. The Friedmann age of such a model is 7×10^9 years, and the mean density is 3×10^{-29} g cm^{-3}. Uncertainties in the values of these parameters are discussed, and it is concluded that there is no irreconcilable discrepancy with ages determined for particular objects, or with mean densities obtained in other ways. (auth)

19699 AN OSCILLATING STATE AS AN ALTERNATIVE TO GRAVITATIONAL COLLAPSE. Leibovitz, C. (Univ. of Alberta, Edmonton). Nature (London); 225: 711-12(21 Feb 1970).

The possibility of an oscillating Universe is often disputed on the grounds that oscillations are not possible when there is no equilibrium position, and by the same argument gravitational collapse can be considered as the only alternative when the mass is over-critical, since there is no equilibrium configuration for such a large mass. The argument, however, cannot be generalized from the cosmological case to that of a large mass. It is shown that the existence of a critical mass of the order of that of the Sun follows from the equation of state obeyed by matter. It is accepted that there is no equilibrium configuration for large masses of cold neutron matter, but as such masses collapse, however, most of the matter may become of over-nuclear density, and the question of restoring forces arises. It is concluded that an over-critical mass could oscillate in the following way: (a) it starts collapsing since it cannot remain in equilibrium; (2) as it collapses the ratio of mass with over-nuclear density to that with under-nuclear density increases, and the equation of state of that part of the body the density of which proceeds from under-nuclear density to over-nuclear density changes; as a result restoring forces build up; (3) under the effect of the restoring forces the collapse ceases and is followed by an expansion process; (4) during expansion the ratio of over-nuclear densities to under-nuclear densities decreases. The body therefore does not cross an equilibrium position, but completes the cycle by reaching the initial state for which no equilibrium position exists. Some further topics for study are mentioned. (UK)

19700 THE EVOLUTION OF DENSITY FLUCTUATIONS IN THE UNIVERSE. II. THE FORMATION OF GALAXIES. Rees, M. J.; Sciama, D. W. (Cambridge Univ., Eng.). Comments Astrophys. Space Phys.; 1: 153-8(Sep-Oct 1969).

In part I the effects of dissipative processes on the evolution of density fluctuations during the early stages of a hot big-bang Universe. In part II the later stages and the problem of galaxy formation are considered. The key phenomenon that divides the early stages from the later ones is the recombination of the hydrogen in the Universe. (W.D.M.)

19701 AN OPEN UNIVERSE. Sunyaev, R. A.; Zel'dovich, Ya. B. (Soviet Academy of Sciences, Moscow). Comments Astrophys. Space Phys.; 1: 159-64(Sep-Oct 1969).

To answer questions on the geometric and topological properties of the Universe as a whole and behavior of the Universe with time, it is sufficient to measure two basic quantities: the smeared-out overall density of all forms of matter in the Universe at present and the cosmological constant Λ. The authors conclude that the observational data are now contradicting the model of a closed world with a future contraction phase; the data are favoring rather an open model with unlimited expansion. (W.D.M.)

19702 BIRKHOFF GRAVITATIONAL FIELD OF MILNE'S UNIVERSE. Boyling, J. B. (Univ. of Leeds, Eng.). J. Math. Phys. (N. Y.); 11: 867-70(Mar 1970).

It is shown that Milne's special relativistic cosmology is consistent with Birkhoff's flat-space theory of gravitation and maintains its stability in the presence of gravity. The gravitational correction to the redshift in the light from distant galaxies is calculated. (auth)

19703 DISCRETE ISOTROPIES IN A CLASS OF COSMOLOGICAL MODELS. Schmidt, B. G. (Cambridge Univ., Eng.). Commun. Math. Phys.; 15: 329-36(30 Dec 1969).

It is shown that a certain class of cosmological models admits discrete isotropies. These models are solutions of Einstein's field equations, characterized by: (1) the matter is described as a perfect fluid, and (2) there exists a group of motions simply transitive on three-surfaces orthogonal to the fluid flow vector. (auth)

Planetary Phenomena

Refer also to abstract 20232.

19704 REFUTATION OF BIGG'S EVIDENCE FOR NEW JOVIAN SATELLITES. Douglas, J. N.; Bozyan, F. A. (Univ. of Texas, Austin). Astrophys. Lett.; 4: 227-8(Dec 1969).

The periodic terms near 20 hr 40 min in the Jupiter decameter radiation time series found by Bigg, and attributed by him to the influence of hitherto-undiscovered Jovian satellites, are shown to be artificial. (auth)

19705 NOVEL CORRELATIONS BETWEEN GLOBAL FEATURES OF THE EARTH'S GRAVITATIONAL AND MAGNETIC FIELDS. Hide, R. (Meteorological Office, Bracknell, Eng.); Malin, S. R. C. Nature (London); 225: 605-9(14 Feb 1970).

It is stated that a significant correlation exists between the Earth's gravitational field and the nondipole part of the geomagnetic field, provided the latter is displaced in longitude. Undulations of the interface between the liquid core and the overlying solid mantle a few km in vertical amplitude (well below the present limit of resolution by seismological methods) might interact so strongly with fluid motions in the core as to produce significant distortions in the geomagnetic field (B) as measured at and near the Earth's surface. Such undulations would also distort the gravitational field (g) and contribute significantly to the low-order harmonies of g at the Earth's surface. Qualitatively, distortions in B could be displaced relative to the undulations through distances at least comparable with the horizontal scale of the undulations (thousands of km). This suggested that the variation of the degree of correlation of g and B with the horizontal displacement of one field relative to the other was worth studying. Such a study is described; attention is confined to displacements in longitude, thus avoiding the complications of transforming spherical harmonic series from one polar axis to another, but physically reasonable since core motions are probably mainly zonal. If the correlation between B and g is a manifestation of strong MHD interactions between core motions and undulations on the core/mantle interface then the main features of the drifting part of the nondipole component of the present geomagnetic field might have been produced by such interaction about 500

years ago; this tentative conclusion is consistent with theoretical ideas concerning the rates of propagation and dispersion of free MHD oscillations of the core and with archeological data. (auth)

19706 UNIPOLAR INDUCTION IN THE MOON AND A LUNAR LIMB SHOCK MECHANISM. Schwartz, K. (American Nucleonics Corp., Glendale, Calif.); Sonett, C. P.; Colburn, D. S. Moon; 1: 7-30(Nov 1969).

The unipolar induction mechanism is employed to calculate electric field profiles in the interior of a chemically homogeneous Moon possessing a steep radial thermal gradient characteristic of long-term radioactive heating. The thermal models used are those of Fricker, Reynolds, and Summers. From the magnetic field, the magnetic back pressure upon the solar wind is found. The electric field profile is shown to depend only upon the activation energy, E_0, of the geological material and the radial gradient of the reciprocal temperature. The current is additionally dependent upon the coefficient of the electrical conductivity function but only by a scale factor. Since the Moon is experimentally known to correspond to the case of weak interaction with the solar wind, the magnetic back pressure is calculated without the need for an iterative procedure. The results indicate that a hot Moon can yield sufficient current flow so that the magnetic back pressure is observable as a vestigal limb shock wave using an activation energy of about $\frac{2}{3}$ eV together with a conductivity coefficient of about 10^3 mhos/m. Such matter is approximated by diabase-like composition, although the result that both the activation energy and coefficient enter into the current determination does not rule out the possibility of a match with other similar substances. The calculations are entirely consistent with earlier results which indicated a model where the unipolar current density is dominated by a high-impedance surface layer and a strong shock wave is inhibited. In addition to the magnetic back pressure, the integration of the current continuity equation permits current densities and joule heating rates to be calculated, though the magnitude of the latter for present solar wind conditions is not thermally important. (auth)

19707 MORPHOLOGY OF THE FINE STRUCTURE IN THE DYNAMIC SPECTRA OF JUPITER'S DECAMETRIC RADIATION. Riihimaa, Jorma J. (Univ. of Colorado, Boulder. Univ. of Florida, Gainesville); Dulk, George A.; Warwick, James W. Astrophys. J., 19: Suppl. Ser.; No. 172, 175-92(Jan 1970).

High-resolution spectral recordings of Jupiter's decametric emission during the years 1963–1968 exhibit several different spectral types. The spectra are classified into three components: the radiation envelope, which has a duration imposed by the interplanetary medium; the substructure within the envelope, which is inherent to the source; and the superimposed, interference-fringe-like modulation lanes, which have an unknown cause but seem to be related to conditions at Jupiter. It is shown how the substructure relates to Jupiter's longitude and Io's position and how the sense of drift of the modulation lanes is characteristic of the longitude facing Earth. Of several suggested mechanisms to produce the modulation lanes, the most likely employ an interference phenomenon. (auth)

19708 CIRCULARLY POLARIZED SYNCHROTRON RADIATION IN DIPOLAR MAGNETIC FIELDS WITH APPLICATION TO THE PLANET JUPITER. Gleeson, L. J.; Legg, M. P. C.; Westfold, K. C. (Monash Univ., Melbourne). Proc. Astron. Soc. Aust.; 1: 274-6(Sep 1969).

Calculations based on the radiation received from a distribution of electrically charged particles, confined to a thin shell in the magnetic field of a dipole, are presented. (Australia)

19709 THE OCCULTATION OF B. D. -17° 4388 BY NEPTUNE ON 1968 APRIL 7. Taylor, Gordon E. Mon. Notic. Roy. Astron. Soc.; 147: 27-33(1970).

All the available observations of the occultation of the star B.D. -17° 4388 by Neptune on April 7, 1968 are discussed. The photoelectric observations are used to provide (a) an extremely accurate determination of the relative positions of the star and the planet and (b) a new value for the diameter of the planet. The 'occultation' diameter (equatorial) thus determined, which presumably corresponds to the upper reaches of the atmosphere of Neptune, is 50,830 km ± (s.d.) 140 km and this is increased to 50,940 km ± (s.d.) 140 km if the correction for the deflection of light in a gravitational field is applied. (auth)

19710 SEARCH FOR VISUAL AURORAE ON JUPITER. Dulk, George A. (Univ. of Colorado, Boulder); Eddy, John A.; Emerson, James P. Astrophys. J.; 159: 1123-4(Mar 1970).

A new search for predicted Jupiter aurorae with high sensitivity but limited space and time coverage revealed no emission with intensity greater than 10 kilorayleighs. (auth)

Atomic and Molecular Physics

Refer also to abstract 19260.

19711 HALLGENERATOREN: EIGENSCHAFTEN UND ANWENDUNGEN. (Hall Generators: Properties and Applications). Kuhrt, Friedrich; Lippmann, Hans Joachim. Berlin, Springer-Verlag, 1968. 321p. DM 63,–; $15.75.

The physical basis of Hall generators is reviewed. Construction of a Hall generator, production methods, characteristics, disturbing influences, and frequency behavior are discussed. Uses of Hall generators in magnetic field measurements, contact and contactless signals for steering and control of motion phenomena, interrogation of magnetically stored information, direct-current measurements, multiplication of two electric values, modulation of small potentials, and transmission elements with gyrator characteristics are discussed. (M.C.G.)

19712 PHYSICS OF THE ONE- AND TWO-ELECTRON ATOMS. Proceedings of the Arnold Sommerfeld Centennial Memorial Meeting and of the International Symposium on the Physics of the One- and Two-Electron Atoms, Munich, 10–14 September 1968. Bopp, F.; Kleinpoppen, H. (eds.). Amsterdam; North-Holland Publishing Company (1969). 887p. $30.25. (CONF-680934).

Separate abstracts were prepared for three sections of the conference. The portions not abstracted separately include proceedings of a commemoration meeting honoring Arnold Sommerfeld and three papers on the following subjects: quantum mechanics of atomic structure, optical methods of rf spectroscopy, and spectroscopy by means of shock waves. (A.G.W.)

For abstracts of individual sections see: 19527, 19734, and 19749.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstract 19981.

19713 (WIS-TCI-325-X) MOLECULAR BEAM FOCUSING OF DIATOMICS IN SELECTED STATES: TWO METHODS. Waech, Theodore Gustav (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). 16 Oct 1968. Contract AT(11-1)-1328. 182p. Dep. CFSTI.

Thesis.

Two methods were developed for the focusing and state selection of diatomic molecules in thermal molecular beams. The first utilizes a pair of four-pole electric fields, with an interposed crossed beam of microwaves, to select beams of chosen vibrational–rotational states. No mechanical velocity selector is needed. The second (requiring a selector) involves a ten-pole electric field that allows weak focusing and selection of rotational states of negative (or positive) Stark energy, including the "rotationless" state J,M = 0,0. A computer program for a polynomial fit to H + H interatomic potentials is included. (auth)

19714 LOW TEMPERATURE ATOMIC ^{3}He BEAM FOR USE IN A POLARIZED $^3He^+$ ION SOURCE. Vyse, R.; Axen, D.; Craddock, M. K. (Univ. of British Columbia, Vancouver). Rev. Sci. Instrum.; 41: 87-90(Jan 1970).

The production of a polarized $^3He^+$ ion beam by Stern–Gerlach splitting of a neutral atomic ^{3}He beam requires slow-moving atoms because of the small nuclear magnetic moment. A miniature supersonic nozzle cooled to liquid helium temperatures was used to produce intense slow beams of both ^{3}He and ^{4}He. Their measured intensities are 1×10^{18} and 0.7×10^{18} atoms/sterad sec, respectively, with corresponding most probable velocities of 310 and 270 m/sec and velocity full widths at half-maximum of typically 50 m/sec. (auth)

19715 LOW CONVERGENCE ELECTRON GUN FOR ENERGIES ABOVE 2 eV. Harting, Erik; Burrows, Keith M. (Univ. of New South Wales, Sydney). Rev. Sci. Instrum.; 41: 97-101 (Jan 1970).

An electron gun is described, which will provide a current of 0.16 μA at 2 eV, in a beam of convergence half-angle 0.03 rad, 2.5 mm in diameter at the space charge limited waist. At electron energies above 12 eV, the beam current is 2.7 μA and independent of energy. (auth)

19716 ELECTRON ENERGY STRAGGLING MEASUREMENTS FOR THICK TARGETS OF BERYLLIUM, ALUMINUM, AND GOLD AT 4.0 AND 8.0 MeV. Lonergan, J. A.; Jupiter, C. P.; Merkel, G. (Gulf General Atomic Inc., San Diego, Calif.). J. Appl. Phys.; 41: 678-88(Feb 1970).

Energy spectra of electrons transmitted through targets of Be, Al, and Au were measured for incident electron energies of 4.0 and 8.0 MeV. The target thicknesses corresponded to 1/5 or 1/3 the range (calculated in the continuous slowing-down approximation) for the incident electron energy. Transmitted electron spectra were measured as a function of emission angle in the forward hemisphere using a magnetic spectrometer. Angular distributions and energy spectra are compared with results calculated with a Monte Carlo computer program (the NBS ETRAN-15 program). The calculations agree with the experimental data within the experimental error of measurement, except for the aluminum target where spectral comparison agree but there exists a normalization discrepancy. A spectral shift is observed in the data from a beryllium target. (auth)

19717 KINEMATIC CORRECTIONS TO ATOMIC BEAM EXPERIMENTS. Robiscoe, R. T.; Shyn, T. W. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 24: 559-62(16 Mar 1970).

The effective velocity distribution for metastable hydrogen atoms produced in a typical beam apparatus was calculated and measured. The distribution is characterized by $U^n \exp(-U^2)$, where $n \simeq 4$ rather than $n = 2$. Modifications of velocity-dependent correlations to beams measurements of the Lamb shift in the first excited state of atomic hydrogen are discussed. (auth)

19718 A NEW METHOD FOR THE PRODUCTION OF ATOMIC BEAMS OF HIGHLY REFRACTORY ELEMENTS AND FIRST ATOMIC BEAM MAGNETIC RESONANCES IN ^{181}Ta. Buettgenbach, S.; Meisel, G.; Penselin, S.; Schneider, K. H. (Univ., Bonn). Z. Phys.; 230: 329-36(1970).

A new universal method for the production of atomic beams of highly refractory elements has been developed. The beams of free atoms are produced by locally heating a small area on a target consisting of the material to be evaporated. The local heating is achieved via the focussed electron beam of a commercial electron gun. The atomic beams so obtained are suitable for studying hyperfine structures by the atomic beam magnetic resonance method. The first observed rf resonances in the ground state $^4F_{\frac{9}{2}}$ and the first excited state $^4F_{\frac{7}{2}}$ of ^{181}Ta are reported. (auth)

19719 ENERGY DISTRIBUTION IN SPUTTERING PROCESSES. Oechsner, H. (Univ., Wuerzburg, Ger.). Phys. Rev. Lett.; 24: 583-4(16 Mar 1970).

The energy distribution $N_i(E_i)dE_i$ of the recoil atoms within polycrystalline targets of Al, Ti, Ni, Cu, and Ag under bombardment with Ar^+ ions of 900 eV are deduced from the measured energy distributions of neutral sputtered particles in the energy range below 20 eV. It is found that $N_i(E_i) \sim (E_i/S)^{-2}$, where S describes the binding energy within the bombarded solid. (auth)

19720 ALPHA-PARTICLE STOPPING CROSS SECTION IN SOLIDS FROM 400 keV TO 2 MeV. Chu, Wei-Kan. Waco, Tex.; Baylor Univ. (1969). 152p.

Thesis.

Stopping cross sections of alpha particles from 400 keV to 2 MeV were measured to ±3.6 to 4.9% accuracy in 17 elements (Be, C, Mg, Al, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Ge, Pd, Ag, In, and Sn). The experimental method consists of the elastic scattering of alpha particles from a thick Ta backing onto which a thin layer of target element has been evaporated. The energy loss of alpha particles in the target film is determined by the difference in energy of alpha particles scattered from clean Ta and from Ta after having gone through the thin layer of target element. The energy loss results are compared with data from Porat and Ramavataram, Gobeli, and Whaling with agreement from 1 to 20%. A decrease of the alpha-particle stopping cross section ϵ_α with the stopping-element atomic number Z_2 is noticed in the region $Z_2 = 22$ to 29. This dependence is not predicted by the Bethe–Bloch formulism valid at higher velocities, nor by the Firsov or Lindhard formulism valid at lower velocities. Experiments by Ormrod, Fastrup, Eriksson and co-workers indicate at lower velocities an oscillatory dependence of ϵ_{ion} on Z_{ion}, but the present experiment constitutes the first known evidence of an oscillation of ϵ_α with Z_2 in the intermediate-velocity region. The oscillatory dependence of ϵ_α on Z_2 is discussed, and an empirical formula $\epsilon_\alpha = \epsilon_\alpha(E, Z_2)$ with ±20% accuracy is constructed. (Disser. Abstr.)

19721 ANALYSIS OF OBSERVATIONS OF INTERPLANETARY SCINTILLATIONS. Lovelace, R. V. E.; Salpeter, E. E.; Sharp, L. E. (Cornell-Sydney Univ., Ithaca, N. Y.). Astrophys. J.; 159: 1, 1047-55(Mar 1970).

It is shown that under suitable conditions it may be possible to derive the speed of the solar wind from observations of interplanetary scintillations taken with a single antenna. Theory suggests that the characteristic diffraction pattern of the interplanetary medium may be identified as a sequence of minima in a Bessel transform of the time autocorrelation function of the observed (weak) variations in intensity; the location of the minima gives the speed of the solar wind. The necessary analysis has been done on scintillation data of CTA 21 taken at 430 MHz. On two occasions, out of eight analyzed, a pattern of deep minima was observed in the Bessel transform. In addition, power spectra of the observed intensity were obtained on all eight occasions, and a number of these spectra could be represented by a power law. It is suggested that the power-law frequency spectra may be interpreted in terms of a power-law wave-number spectrum of irregularities in electron density in the solar wind. (auth)

19722 A BETA-SPECTROMETRIC STUDY OF PLURAL AND MULTIPLE SCATTERING OF ELECTRONS THROUGH INTERMEDIATE ANGLES IN THIN MATERIAL LAYERS. Oms, Jacques; Erman, Peter; Hultberg, Soelve (Research Inst. for Physics, Stockholm). Ark. Fys.; 39: 573-83(1969).

The scattering of electrons isotropically emitted by point sources was studied for different annular-shaped scatterers using beta-spectroscopic techniques. The experimental results were compared with values derived from the different theoretical calculations by Moliere, Nigam et. al., and Keil et. al. It was found that the electron scattering can be reasonably well represented by a combination of these theories. From a practical point of view, it was therefore concluded that scattering corrections calculated from these theories should be applicable to similar experimental situations where electrons are incident on material slabs under oblique angles. (Sweden)

19723 SECOND INTERNATIONAL SYMPOSIUM ON HIGH- AND MEDIUM-ENERGY MOLECULAR JETS, CANNES, FRANCE, JULY 1–4, 1969. Entropie; No. 30, 1-194(Nov-Dec 1969). (In English and French). (CONF-690709).

Separate abstracts were prepared for 12 of the 42 papers included. The papers not abstracted deal with production, properties, and applications of atomic and molecular beams, particularly with their use in studies of gas–surface interactions. (A.G.W.)

For abstracts of individual papers see: 19724–19726 and 19756–19764.

19724 ELASTIC SCATTERING OF ELECTRONS FROM SOLIDS. Nikuradse, A.; Weiss, H. F. (Institut fuer Elektronen-und Ionenforschung, Munich). Entropie; No. 30, 88-92(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

The reflection of electrons from solids is treated quantum mechanically. As a first step the elastic scattering from a single surface atom representing the solid is considered. For that purpose we use the Dirac wave equation. As an example the scattering intensities for gold and tungsten are given. In a second step the scattering from a perfect lattice is considered, taking into account the heat motion. Then some numerical results for the elastic scattering from the (001) surface plane of the face-centered cubic lattices of gold and tungsten are presented. (auth)

19725 SOME RECENT TRENDS AND ADVANCES IN MOLECULAR BEAM RESEARCH. Amdur, I. (Massachusetts Inst. of Tech., Cambridge); Jordan, J. E.; Mason, E. A. Entropie; No. 30, 135-43(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

A review is presented of selected recent developments in experiments involving two-body collisions. The review discusses advances associated with high- and low-energy beams, and also with beams of intermediate energy. In the description of new experimental techniques, mention is made of methods for internal state selection, production of moderate-energy beams and the use of energy analysis of products as a method for detecting inelastic processes such as rotational and vibrational excitation and de-excitation. In discussing new experimental results, examples are given of systems where such inelastic events have been observed. With respect to the determination of intermolecular potentials, it is pointed out that for several systems there is now good agreement between experiment and theory and also between the results from different laboratories. The successful use of inversion procedures for deducing intermolecular potentials from scattering experiments without assuming a semi-empirical functional form is shown in the determination of potentials where it is necessary to take account of both repulsion and attraction. 97 references. (auth)

19726 MEASUREMENT OF THE ROTATIONAL STATE DISTRIBUTION OF A MOLECULAR BEAM. Scott, P. B.; Mincer, T. (Univ. of Southern California, Los Angeles). Entropie; No. 30, 170-3(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

The measurement of the rotational temperature of a molecular beam is discussed and demonstrated. The electron-beam-excited fluorescence method is applied using a specially built electron gun and a spectrograph. The molecular beam is of the nozzle–skimmer type, with nitrogen used as a test gas because of its strong fluorescence. Signal level, background light, and molecule scattering effects are discussed. (auth)

19727 RARE-GAS SCATTERING FROM LiF: CORRELATION WITH LATTICE PROPERTIES. II. Smith, Joe N. Jr.; O'Keefe, D. R.; Palmer, R. L. (Gulf General Atomic Inc., San Diego, Calif.). J. Chem. Phys.; 52: 315-20(1 Jan 1970).

The scattering of thermal-energy atomic beams of Ne, Ar, Kr, and Xe from the (001) face of LiF was studied. Two dominant peaks in the scattering distributions in the plane of incidence are observed: one peak remains fixed with respect to the crystal whereas the position of the other displays a strong dependence on angle of incidence, incident energy, and azimuthal orientation of the target. The former peak is associated with the normal modes of the lattice, in particular with dipole–induced dipole attractive forces produced by longitudinal optical modes in next-nearest-neighbor unlike ion directions. The latter peak is discussed in terms of the surface properties of the crystal, e.g., interaction potential and elastic properties, the latter acting on the transfer of tangential momentum. For Ne, additional peaks occur, which arise from diffraction effects. The present results provide additional insight into the phenomenon of preferential scattering reported earlier and strongly emphasize the inadequacies of existing theoretical descriptions of thermal energy atomic and molecular scattering from surfaces, especially when applied to the surfaces of ionic crystals. (auth)

19728 SCATTERING OF 0.06- TO 2.5-eV NEON AND ARGON ATOMS FROM A SILVER (111) CRYSTAL. Miller, D. R.; Subbarao, R. B. (Univ. of California, San Diego, La Jolla). J. Chem. Phys.; 52: 425-31(1 Jan 1970).

Reflected density distributions of argon and neon scattered from the (111) plane of a silver crystal were examined at incident energies from 0.06 to 2.5 eV. Two regimes of scattering were detected in which the characteristic properties of the reflected distribution, direction and width, reverse their behavior as a function of incident energy. This confirms the recent theoretical work of Oman, wherein he characterizes the two regimes as thermal scattering and structure scattering. The data suggest that, for scattering at incident energy E_i and angle θ_i, the transition from one type of interaction to the other is characterized by one critical value of $E_i \cos\theta_i$. For argon, this critical value is near 0.21 eV and for neon 0.108 eV. At these critical energies the velocities of argon and neon are nearly identical. At a given incident angle, a maximum degree of supraspecular scattering exists, which is less for neon than for argon. (auth)

Atomic and Molecular Properties

Refer also to abstracts 19547, 19652, 19660, 19662, 19665, 19877, and 20201.

19729 ORDER α^2 ELECTRODYNAMIC CORRECTIONS TO THE LAMB SHIFT. Appelquist, Thomas; Brodsky, Stanley J. (Stanford Linear Accelerator Center, Calif.). Phys. Rev. Lett.; 24: 562-5(16 Mar 1970).

The fourth-order radiative correction to the slope at $q^2 = 0$ of the Dirac form factor of the free-electron vertex is calculated using computer techniques. The result, $m^2 \partial F_1^{(4)}(0)/\partial q^2 = (\alpha/\pi)^2$ [0.48 ± 0.07], disagrees with previous calculations and implies a new theoretical value for the order $\alpha^2(Z\alpha)^4 mc^2$ contribution to the Lamb shift. The new values for the $2S_{\frac{1}{2}}-2P_{\frac{1}{2}}$ separation in H and D are increased by (0.35 ± 0.07) MHz and are in good agreement with the results of recent experiments. (auth)

19730 MOLECULAR-BEAM RESONANCE MEASUREMENT OF DEUTERIUM POLARIZABILITY ANISOTROPY. English, Thomas C.; MacAdam, Keith B. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 24: 555-7(16 Mar 1970).

The molecular-beam magnetic resonance method was used to measure directly the anisotropy of the static electric polarizability of the deuterium molecule. This is the first measurement of this quantity for any molecule using the molecular-beam resonance method. (auth)

19731 SOME ACCURATE RESULTS FOR THREE-PARTICLE SYSTEMS. Kolos, W. (Univ. of Warsaw). Acta Phys. Acad. Sci. Hung.; 27: 241-52(1969).

Results of a variational calculation of the nonadiabatic ground-state energy of H_2^+ are presented. Diagonal corrections for nuclear motion were also calculated for the electronic ground state of H_2^+. The adiabatic potential-energy curve was employed to calculate the rotational and vibrational levels for the H_2^+ ion and for muonic molecules. Nonadiabatic energy corrections are discussed. For $p\mu d$ the adiabatic wave function is compared with the corresponding nonadiabatic result. (auth)

19732 MEAN EXCITATION ENERGIES FOR CHEMICAL ELEMENTS. Turner, J. E.; Roecklein, Patricia D.; Vora, R. B. (Oak Ridge National Lab., Tenn.). Health Phys.; 18: 159-60 (Feb 1970).

Values of atomic mean excitation energy, I, for chemical elements, obtained from previously reported experimental data (Dalton, Patricia; Turner, J. E., Oak Ridge National Lab. Report ORNL-TM-1777 (1967)) are listed. Also some modifications of an earlier paper (Dalton, Patricia; Turner J. E., Health Phys., 15: 257 (1968)) giving I values of compounds and mixtures used in radiation dosimetry are made. (UK)

19733 SIMPLIFIED CALCULATION OF LAMB SHIFT USING ALGEBRAIC TECHNIQUES. Huff, Robert W. (Univ. of California, Los Angeles). Phys. Rev.; 186: 1367-79(25 Oct 1969).

The Lamb shift in hydrogen-like atoms is treated by algebraic matrix methods using a unitary, infinite-component representation of the group SO(4,2). The result for the Lamb shift itself, with its dependence upon the Bethe logarithm of the average excitation energy, is identical to previous results, but is obtained more simply. The numerical evaluation of the Bethe logarithm is both simpler and more accurate than by earlier treatments, as demonstrated by a detailed evaluation for the ground state. Numerical values for the Bethe logarithm (obtained without the use of an electronic computer) are $\gamma(1S) = 2.98412\ 85559(3)$, $\gamma(2S) = 2.81176\ 98932(5)$, and $\gamma(2P) = -0.03001\ 67089(3)$ for the three lowest states, with the figures in parentheses giving the number of units of estimated error in the last decimal place. A series of appendices presents the needed properties of SO(p,1) and SO(p,2) representations, the SO(4,2) formulation of the hydrogen atom, and an alternative treatment of the Bethe logarithm, which may also be applied to other operators such as the Coulomb Green's function. (auth)

19734 ATOMIC CONSTANTS AND SPECTROSCOPY. pp 117-510 of Physics of the One- and Two-Electron Atoms. /Bopp, F. (ed.). Amsterdam; North-Holland Publishing Co. (1969).

From Conference on Physics of the One- and Two-Electron Atoms, Munich, Germany. See CONF-680934.

Twenty-nine papers on the following subjects are included: experiments on atomic constants and the numerical value of the Sommerfeld fine structure constant, a measurement of the Sommerfeld fine structure constant by level crossing in atomic hydrogen, a determination of g_l/g_p in atomic hydrogen, electric dipole moments of atoms and an upper limit to the electric dipole moment of the electron, the electric dipole moment of the neutron, theory of quantum electrodynamics, theory of the Lamb shift, hyperfine structure in the ground state of the one-electron atom, atomic hydrogen hyperfine structure, hyperfine spectrum of $^3He^+$ by the ion storage collision technique, correspondence identities, spontaneous two-photon transitions in hydrogen and helium, coherence effects in the interaction of radiation with atoms, two-photon decay of the metastable helium ion, light shifts and multiple quantum transitions, fine structure and hyperfine structure of ^4He and ^3He, spectroscopy of atomic excited states by electronic impact excitation, spectroscopy of excited states by photon excitation, zero-field level crossing in stepwise excitation of Cd, level-crossing experiments in the Mn I spectrum, periodic intensity fluctuations in beam–foil excited hydrogen, excitation of the n = 5 states of He^+ in beam–foil collisions, study of atomic spectra with excited ion beams, muonium and positronium, recent progress in muonic atoms, measurements and calculations on pionic atoms, isotope shifts of K x rays and nuclear charge radii, and photoproduction of electron pairs at high energies. Most of the papers are review-type and are accompanied by numerous references. (A.G.W.)

19735 LEVEL-CROSSING RESONANCES IN ATOMIC GROUND STATES: POSSIBLE APPLICATIONS. Cohen-Tannoudji, C. Comments At. Mol. Phys.; 1: 150-4(Dec 1969–Jan 1970).

The physical meaning of level-crossing signals in atomic excited states and the basic principle of level-crossing experiments are analyzed briefly. Observation of similar resonances in atomic ground states, by use of optical pumping, is discussed. Other possible applications of this device for measuring very weak magnetic fields are suggested. (A.G.W.)

19736 HELIUM-ATOM–HYDROGEN-MOLECULE POTENTIAL SURFACE EMPLOYING THE LCAO–MO–SCF AND CI METHODS. Gordon, Michael David; Secrest, Don (Univ. of Illinois, Urbana). J. Chem. Phys.; 52: 120-31(1 Jan 1970).

Wave functions and interaction energies are calculated for the helium-atom–hydrogen-molecule system at a wide range of internuclear separations. Letting X represent the distance measured along a line drawn from the helium nucleus to the midpoint of the hydrogen molecule, R the H_2 bond distance, and θ the angle between X and R, results are reported for $2.8 \leq X \leq 7.0$ a.u., $1.0 \leq R \leq 1.8$ a.u. (R_e = 1.4 a.u.), and $0° \leq \theta \leq 90°$. The orbital basis set consisted of Slater s and p orbitals, and all integrals are accurately evaluated. The wave functions are constructed by each of the two major approaches to molecular bonding; the self-consistent-field molecular-orbital method of Roothaan and the configuration-interaction method. The value of the two methods in atom–diatomic-molecule interactions is compared extensively. For each individual method, the effect of the size of the basis set on the resultant interaction energy is examined. The values for the He–H_2 interaction energies obtained by the self-consistent-field and configuration-interaction method are very similar. The self-consistent-field method appears adequate for the calculation of interaction energies for closed-shell noninteracting systems except at large center-of-mass separations. The interaction energies are accurately fit to an analytic expression for the intermolecular potential. Configuration-interaction calculations performed at large center-of-mass separations fail to locate the He–H_2 van der Waals minimum. (auth)

19737 SECOND-ORDER PERTURBATION TREATMENT OF THE GROUND STATE OF H_2^+. Jackson, M. (York Univ., Toronto); McEachran, R. P.; Cohen, M. J. Chem. Phys.; 52: 102-6(1 Jan 1970).

Rayleigh–Schroedinger perturbation theory was used through second order to obtain an analytic representation for the ground-state wave function of H_2^+. Values of the electronic energy and other molecular properties computed with this approximate wave function are compared with the corresponding exact values, and they demonstrate its high accuracy. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 19992 and 20111.

19738 EFFECT OF THE POSITRON–PHONON INTERACTION ON POSITRON MOTION. Perkins, A.; Carbotte, J. P. (McMaster Univ., Hamilton, Ont.). Phys. Rev., B; 1: 101-7 (1 Jan 1970).

A calculation is made of the effect of the positron–phonon interaction on positron motion in simple cubic metals. A slightly modified jellium model is used to treat the positron–phonon interaction, and several approximations are introduced. It is felt that the calculations are qualitatively correct, and it is concluded that phonons must play a role in determining positron motion in metals at low temperatures. In this region, phonon excitation provides an important additional mechanism for energy loss although it does not appear to contribute significantly to the effective positron mass. (auth)

19739 LIFETIMES OF DEEPLY EMBEDDED POSITRONS IN METALS. Souder, Wallace William. Iowa City, Iowa; Iowa State Univ. (1969). 185p.

Thesis.

Measurements of mean lifetimes of positrons deeply imbedded in metals were made. The resolving power of the apparatus with one channel accepting the top 30% of the 1.33-MeV spectrum and the other channel accepting the top 15% of the 0.511-MeV spectrum is represented by a full width at one-half the maximum of the prompt curve of 214 psec. Nuclear isotopes that emit positrons were created deep within samples by photonuclear reactions induced by the bremsstrahlung radiation of an electron synchrotron. The positron annihilation rate was shown to depend upon surface effects by measuring the lifetimes of positrons in samples of nickel in which varying percentages of annihilations occurred near the surface. The mean lifetime of positrons deeply imbedded in a large single crystal of nickel was found to be 119 ± 5 psec. The value 186 ± 6 psec was measured for positrons annihilating in the conventional sandwich sample made from two nickel single crystals. Other values obtained include: potassium with ^{39}K, τ_1 = 128 ± 7 psec, τ_2 = 414 psec, I_2 = 24%; molybdenum with ^{91}Mo, τ_1 = 152 ± 6 psec, τ_2 = 760 psec, I_2 = 16.2%; zinc with ^{63}Zn, τ_1 = 187 ± 5 psec, I_2 ≈ 0%; scandium with ^{44}Sc, τ_1 = 217 ± 5 psec, τ_2 = 870 psec, I_2 = 3.9%; silver with ^{106}Ag, τ_1 = 52 ± 5 psec, I_2 ≈ 0%; and sodium with ^{22}Na, τ_1 = 262 ± 5 psec, I_2 ≈ 0%. (τ is intensity, τ is mean lifetime, and the subscript 2 indicates the component due to surface effects.) There was no apparent agreement with any theory. A plot of λ versus r_s showed no obvious trend. It was concluded that positron lifetime measurements may be meaningless unless care is taken to ensure that positrons annihilate in the interior of the metal single crystals. (Disser. Abstr.)

19740 DEPENDENCE OF THE POLARIZATION OF μ MESONS IN MESIC ATOMS ON THE HYPERFINE INTERACTION CONSTANTS. Tammet, Eve. Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 18: 350-2(1969). (In Russian).

A mesic atom with uncompensated electron-shell moment was studied. Although the μ meson at the time of arrival at the K shell has initial polarization P_0, it is partially depolarized by hyperfine interactions with the nucleus and the electron shell. Curves of μ-meson polarization as functions of hyperfine interaction constants under various conditions were constructed. (R.V.J.)

19741 FORMATION OF THE MESIC DEUTERIUM MOLECULE. Vesman, E. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 18: 429-37(1969). (In Russian).

Using the corrected adiabatic approximation, the level of the mesonic molecule ddμ in the rotational state K = 1 with the vibrational quantum number $\nu = 1$ is estimated to have the binding energy $|E_d| < 3$ eV. The formation of the mesic molecule ddμ at an electric dipole transition is discussed. The initial state is the S-state of the continuous spectrum. The final state is ddμ at the level K = 1, $\nu = 1$. The binding energy E_d of this level is considered to excite the vibrational levels of the big molecule consisting of an ion $(dd\mu)^+$, a nucleus d, and electrons. Assuming the initial atoms dμ to have the Maxwell distribution, the experimental material is analyzed. The rate of the formation of ddμ as the function of the average kinetic energy $\bar{E}$ of the dμ atom is found to have a maximum $w_{max} = 1.2 \times 10^6$ sec^{-1} when $\bar{E} \approx 0.016$ eV. A comparison of the theoretical expression with the experimental results suggests $|E_d| \approx 1.5$ to 2 eV. The theoretical curve and the experimental points are shown in a figure. There is more than one formation rate maximum; the next maximum is about one-tenth the previous one. If the concentration of the deuterium in gas is small, almost all the deuterium is in HD molecules. A difference in the formation of the ddμ molecule when the dμ atom approaches the HD molecule as compared with the formation if the dμ atom approaches the D_2 molecule is suggested. Namely: (1) in the first case, the maximum lies rather in the region of the point $\bar{E} \approx 0.25$ eV than at $\bar{E} \approx 0.016$ eV; (2) the maximum rate of the formation of ddμ increases 16 to 32 times as compared with the second case, since the integral $I_2(v)$ increases. The points at $\bar{E} = 0.17$ eV and at $\bar{E} = 0.012$ eV on the figure are those of experiments made at a small concentration of deuterium. (auth)

19742 ELECTRIC DRIFT OF POSITRONS IN HELIUM. Rodionov, S. N.; Sannikov, B. P.; Solodov, E. P. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 10: 325-6(5 Dec 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 509-11(5 Dec 1969).

The change in the number of positrons from a ^{22}Na source reaching a target in a gas-filled chamber was investigated as a function of gas pressure and of an applied longitudinal electric field. Results are shown for He at pressures of 100, 280, 410, and 510 torr. An increase of the counting rate was observed in a narrow interval of the values of E/P (~3 to 6 V/cm atm.). The absolute increase of the counting rate was found to depend strongly on impurities. (A.G.W.)

19743 DETERMINATION OF THE ENERGY OF INTERACTION BETWEEN ATOMIC POSITRONIUM AND MOLECULES OF THE MEDIUM. Urbanovich, S. I. (Inst. of Physics, Minsk). Zh. Eksp. Teor. Fiz.; 58: 641-6(Feb 1970). (In Russian).

The possibility of determining the magnitude of the energy of interaction between the hydrogen-like positronium atom and molecules (atoms) of the surrounding medium is considered on the basis of spectroscopic data relating to energy-level shifts. The method proposed is also employed for describing the hyperfine structure level shifts in other atoms such as tritium, muonium, etc. The magnitudes of the interactions mentioned are determined by taking into account available experimental data. Use of the method for describing the Stark effect of the hydrogen-atom ground state is discussed. (auth)

Collision Phenomena

Refer also to abstracts 19261, 19618, 20035, 20049, 20064, and 20108.

19744 (ORO-3650-3) CHARGED PARTICLE INTERACTIONS WITH NOBLE GASES. Annual Progress Report, April 15, 1969–April 14, 1970. Hurst, G. S. (Kentucky Univ., Lexington. Dept. of Physics and Astronomy). Jan 1970. Contract AT(40-1)-3650. 41p. Dep. CFSTI.

Progress is reported briefly on proton excitation of argon, helium, and xenon. Plans for lifetime measurements using the 250-keV pulsed electron accelerator and for oscillator strength measurements are noted. A paper to be submitted for publication on collisional destruction of the $6\ ^3P_1$ state of Hg is included. (A.G.W.)

19745 ASYMPTOTIC BEHAVIOR OF CHARGE EXCHANGE CROSS SECTIONS IN LOWEST-ORDER PERTURBATION THEORY. Potapov, V. S.; Brodskii, A. M.; Tolmachev, V. V. Vestn. Mosk. Univ., Ser. III. Fiz. Astron., No. 4, 52-9(July-Aug. 1969). (In Russian).

The behavior of the amplitude of nonrelativistic scattering of a fast proton on a hydrogen atom (1s) with electron exchange is calculated in the first order of perturbation theory. The results are compared with second and third orders of perturbation theory, and the inaccuracy in the amplitude is indicated. The contributions of separate terms of the second order of perturbation theory to the differential and total cross section are studied in detail. There is proposed a general method of studying the asymptotic form of integrals encountered in the lower orders on breaking down the charge-exchange amplitude into a perturbation-theory series. (TTT)

19746 ASYMPTOTIC BEHAVIOR OF CHARGE-EXCHANGE CROSS SECTIONS IN LOW-ORDER PERTURBATION THEORY. TERMS OF THE SECOND AND THIRD ORDERS. Potapov, V. S.; Brodskii, A. M.; Tolmachev, V. V. Vestn. Mosk. Univ., Ser. III, Fiz. Astron.; No. 5, 17-27(Sep-Oct 1969). (In Russian).

Studies were made of the second-order terms in the expression for the charge-exchange amplitude for $1s \rightarrow 1s$ scattering of fast protons on hydrogen atoms. An attempt was made to evaluate the contribution of the terms of the third order, and formulas were written for differential and total cross sections. The methods and calculations were described previously by V. S. Potapov et al., Vestn. Mosk. Univ. Fiz. Astron. No. 4, 52, 1969. (R.V.J.)

19747 $H^+ + H^-$ MUTUAL NEUTRALIZATION CROSS SECTION OBTAINED WITH SUPERIMPOSED BEAMS. Moseley, John; Aberth, William; Peterson, James R. (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev. Lett.; 24: 435-9(2 Mar 1970).

The ion–ion mutual neutralization cross section for $H^+ + H^-$ was measured over the barycentric energy range from 0.15 to 300 eV using a merged-beam technique. The results are compared with theoretical calculations and with a recent higher-energy experimental measurement. An estimate of the thermal rate coefficient is made. (auth)

19748 DIFFRACTION OF X RAYS AND ELECTRONS BY MOLECULES. VII. DETERMINATION OF THE VELOCITY DISTRIBUTIONS IN A SCATTERING SYSTEM BY STUDY OF EJECTED ELECTRONS. Tavard, Claude; Bonham, Russel A. (Indiana Univ., Bloomington. Faculte des Sciences, Orsay, France. Centre de Mecanique Ondulatoire Appliquee, Paris). J. Chim. Phys.; 66: 1624-30(Oct 1969). (In French).

A method for the calculation of the differential cross section for ejection of electrons from an ionizing collision is presented. When the incident particle is an electron, the treatment formally accounts for exchange effects as well as effects resulting from the charge polarization of the target. The zeroth-order term in the theory requires only a knowledge of the first- and second-order density matrices in momentum space describing the initial state of the target. A preliminary application to the case of the hydrogen atom shows that the study of ejected electrons is a severe test for proposed theories dealing with the ionized states of the scattering system. (auth)

19749 ATOMIC COLLISION PROCESSES. pp 511-800 of Physics of the One- and Two-Electron Atoms. /Bopp, F. (ed.). Amsterdam; North-Holland Publishing Co. (1969).

From Conference on Physics of the One- and Two-Electron Atoms, Munich, Germany. See CONF-680934.

Twenty papers are included on the following subjects: theory of collisions of electrons with one- and two-electron atoms and ions, scattering of electrons by hydrogen and helium atoms, continuum atomic processes, survey of electron–atom collision experiments, recent experimental progress in e–H, e–He^+, and e–He resonance scattering, polarization of atomic line radiation, polarization of the singlet transitions of He excited by proton impact, high-resolution impact spectroscopy of He, summary of recent spin-analyzed electron–potassium differential-cross-section measurements, asymptotic form of the wave function for the ionization problem, theory of electron impact ionization of atoms, photoionization of one- and two-electron atoms, theory and observation of relativistic electron bremsstrahlung, electron-beam polarization by spin-exchange collision, polarized electrons from polarized atoms, polarized electrons by scattering, heavy-particle collision spectroscopy, depolarization by collisions, state-transfer collisions, and comparison of classical theories and experiments on energy distribution of electrons from ionization of helium and hydrogen by proton collisions. Most papers are review-type and are accompanied by numerous references. (A.G.W.)

19750 ANGULAR DISTRIBUTION OF ELECTRONS RELEASED IN ATOMIC COLLISIONS. Ogurtsov, G. N.; Flaks, I. P.; Avakyan, S. V. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 10: 338-40(5 Dec 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 532-5(5 Dec 1969).

The angular distribution of electrons released in collisions of the pairs H^+–Ar, Ne^+–Ar, Ar^+–Ne, and Ar^+–Ar at angles of 30 to 70° and at an ion energy of 15 keV was investigated. Differential electron-production cross sections are shown for electron energies of 20 and 100 eV. In the case of H^+–Ar, the cross section decreases continuously with increasing scattering angle. For the other collisions studied, the cross sections for 100-eV electrons are practically independent of scattering angle. The cross sections for 20-eV electrons decrease with increasing angle but not as rapidly as in the case of H^+–Ar. Mechanisms that might possibly account for these results are discussed briefly. (A.G.W.)

19751 INELASTIC SCATTERING OF ELECTRONS BY NOBLE GAS ATOMS. Amus'ya, M. Ya.; Cherepkov, N. A.; Sheftel, S. I. (Physical-Technical Inst., Moscow). Zh. Eksp. Teor. Fiz.; 58: 618-23(Feb 1970). (In Russian).

The differential cross section for inelastic scattering of keV electrons by neon, argon, krypton, and xenon atoms is studied for small energy losses. The calculation is carried out in the Born approximation and the wave functions of the Herman–Skillman potential are employed for the ejected electron. The dipole transition of the atomic electron yields the main contribution to the cross section; however, the shape of the curve significantly depends on the contribution of transitions of other multipole order. The results are compared with experiments. Some peaks in the differential cross section for scattering by outer shells of argon, krypton, and xenon atoms are explained. The discrepancy between the calculated and experimental values of the cross sections is analyzed. (auth)

19752 VIBRATIONAL RELAXATION WITH AN ANISOTROPIC INTERMOLECULAR POTENTIAL. Child, M. S. (Physical Chemistry Lab., Oxford). Proc. Roy. Soc. (London), Ser. A; 315: 259-69(24 Feb 1970).

The quantum mechanical theory of vibrational excitation of a diatomic molecule by collision with an atom is developed so as to allow the molecular rotation to relax under the perturbation because of the angular dependence of the internal potential. In the impact region near the classical turning point the perturbed rotation is better regarded as pseudo-vibration, centered on the energetically favoured broadside configuration. For a thermal distribution over initial rotational states, the average excitation cross section is shown to include a novel factor, f_{vib}^{+2}/f_{rot}, where f_{rot} is the initial rotational partition function and f_{vib}^{+2} is a partition function for the pseudo-vibration, with each term modified by a factor that represents the mean steric and anharmonicity correction for the state in question. Calculations on the H_2 + He system indicate that, particularly for heavy diatomic molecules, with a strongly anisotropic potential, the magnitude of the cross section may be reduced by one or two orders of magnitude by this modification of the theory, but that its temperature dependence is relatively unaffected. (auth) (UK)

19753 PERTURBED STATIONARY STATE APPROXIMATION FOR COLLISIONS BETWEEN SLOW ATOMS OR IONS. Bates, D. R. Comments At. Mol. Phys.; 1: 127-34(Dec 1969–Jan 1970).

The use of eigenfunctions of the quasi molecule formed by the colliding system as basis functions for treatment of collisions between slow atoms and ions is considered. For slow H^+–H(1s) collisions, calculations using basis functions having a rotating polar axis are compared with calculations using basis functions having a fixed polar axis. Possible variations in the method and sources of error are considered. (A.G.W.)

19754 REPORT ON ELASTIC COLLISIONS OF LOW-ENERGY ELECTRONS WITH ALKALI METALS. I. Bederson, Benjamin. Comments At. Mol. Phys.; 1: 135-9(Dec 1969–Jan 1970).

The present situation regarding calculations of the elastic chan-

nel in the alkali metals by close-coupling and other techniques is summarized. The other techniques involve chiefly the selection of some form of an adiabatic potential that includes polarization and the subsequent solution of the Schroedinger equation with proper symmetrization in some suitable approximation. Results of recent calculations are presented briefly in a table. It is concluded that the close-coupling method is preferred if a sufficient number of states can be included. It is also observed that almost all the calculated results are substantially lower than results of measurements made to date. (A.G.W.)

19755 EFFECT OF THE CENTRIFUGAL FORCE ON ELECTRON–MOLECULE INTERACTIONS. Fano, Ugo. Comments At. Mol. Phys.; 1: 140-4(Dec 1969–Jan 1970).

The nature and effects of the centrifugal potential encountered in electron–molecule interactions are reviewed. The main effect seems to be that, whereas the orbital angular momentum of an electron should not generally be a constant of the motion in the presence of noncentral forces, discrete energy levels of Rydberg series and eigenstates of scattering matrices for low-energy electrons have been successfully classified by an orbital quantum number l. Another effect emerges from the occurrence of shape resonances in electron scattering at the energy necessary for the incident electron to clear the barrier. Considerations of centrifugal force in solution of the Schroedinger equation are discussed. (A.G.W.)

19756 DETERMINATION OF THE INTERMOLECULAR POTENTIAL OF ATOMS AND/OR MOLECULES BY MEANS OF SUPERSONIC MOLECULAR BEAM SCATTERING EXPERIMENTS. Schimpke, B.; Eckelt, W. R.; Schuegerl, K. (Technische Univ., Brunswick). Entropie; No. 30, 143-5(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

The effective total cross sections of helium and argon atoms were determined on argon atoms, nitrogen, methane, and ethane molecules as function of the relative energy of the scattering partners by measuring the attenuation of the intensity of supersonic helium and/or argon atomic beams. The latter passed a scattering chamber at different pressures of the scattering gas. The effective total cross sections were calculated using the JWKB approximation and the Lennard–Jones 12–6 potential. The potential parameters were estimated by fitting the calculated functions to the measured ones. (auth)

19757 DETERMINATION OF THE EFFECTIVE TOTAL SCATTERING CROSS SECTIONS OF POTASSIUM ATOMS ON BROMINE MOLECULES USING SUPERSONIC ALKALI ATOMIC BEAMS. Lassalle, J.; Schuegerl, K. (Technische Univ., Brunswick). Entropie; No. 30, 145-8(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

The intensities of supersonic potassium atomic beams were found to be a factor of about 10^3 higher than those of the corresponding classical atomic beams at stagnation pressures of about 1 torr. The Mach numbers were relatively low because of the low stagnation pressures in the oven. The effective total cross sections of potassium atoms on argon atoms and bromine molecules were determined as functions of the relative energy of the scattering partners using a scattering chamber. The same functions were calculated by solving the Schroedinger equation using the JWKB approximation and the Lennard–Jones 12–6 potential, then integrating this function over the velocity distribution of the scattering particles. The parameters of this potential were estimated by fitting the calculated functions to the measured ones. (auth)

19758 ROTATIONAL TEMPERATURE DEPENDENCE OF THE TOTAL SCATTERING CROSS SECTION OF N_2 ON RARE GASES. Phipps, John A.; Scott, John E. Jr. (Univ. of Virginia, Charlottesville). Entropie; No. 30, 148-54(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

An experimental study of the effect of rotational excitation of a molecular beam of nitrogen on the total scattering cross section on argon and krypton is described. The experiments were performed in an attempt to account for an inconsistency observed in the Ar–N_2 system when the scattering partners were reversed. At values of the N_2-beam rotational temperature below 50°K, the rate of change of total scattering cross section with respect to beam rotational temperature was found to be of the order of -0.1 Å^2/°K. At larger values of beam rotational temperature, the experimental results cannot be subjected to unambiguous interpretation. Although no physical significance can be ascribed to these results at present, it is hoped that theoretical interest in this effect will be stimulated by these observations, and that they will emphasize the caution that must be observed in the interpretation of scattering results obtained with beams produced by aerodynamic acceleration. (auth)

19759 MEASUREMENT OF Ar–Kr AND Ar*–Kr CROSS SECTIONS AT INTERMEDIATE ENERGIES WITH AN ARC-HEATED AERODYNAMICALLY INTENSIFIED ATOM BEAM. Winicur, Daniel H.; Knuth, Eldon L.; Rodgers, Wayne E. (Univ. of California, Los Angeles). Entropie; No. 30, 154-9(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

Relative values of $Ar(^1S_0)-Kr(^1S_0)$ integral scattering cross sections are reported for relative velocities from 1.5 to 2.0×10^5 cm/sec (0.47 to 0.85 eV). Values for $Ar^*(^3P)-Kr(^1S_0)$ cross sections are reported from 1.82 to 2.6×10^5 cm/sec (0.67 to 1.4 eV). Ratios of these cross sections are given from 1.8 to 2.2×10^5 cm/sec. The measurements were made using a variable energy, arc-heated aerodynamically intensified (supersonic) argon beam and a liquid-nitrogen-cooled, krypton-filled scattering chamber. The experimental results are compared with theoretical calculations to obtain information about the intermolecular potential-energy curves of Ar–Kr and Ar*–Kr. (auth)

19760 ENERGY DEPENDENCE OF THE ELASTIC TOTAL COLLISION CROSS SECTION OF IDENTICAL MOLECULES: ^{4}He. Dondi, M. G. (Univ., Genoa); Scoles, G.; Torello, F.; Pauly, H. Entropie; No. 30, 162-4(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

The velocity dependence of the total collision cross section for velocity-selected molecular beams of ^{4}He scattered by ^{4}He at 2°K was measured. Undulations due to the quantum statistics were resolved between 650 and 1200 m sec^{-1}. Results are compared with exact and approximate calculations and the sensitivity of this effect to potential parameters is discussed. (auth)

19761 TOTAL CHARGE TRANSFER CROSS SECTIONS OF ALKALI ATOMS ON HALOGEN MOLECULES. Baede, A. P. M.; Mouthino, A. M. C.; De Vries, A. E.; Los, J. (FOM–Instituut voor Atoom- en Molecuulfysica, Amsterdam). Entropie; No. 30, 165-7(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

The total cross sections are determined for ion production from collisions of alkali atoms and bromine molecules. A beam of alkali atoms with energies in the eV region is produced by a sputter source. The collision chamber is described and a short analysis of the experimental results is given, partly based on the Landau–Zener theory. (auth)

19762 SHOCK IONIZATION ON A GASEOUS TARGET OF HYDROGEN TRIATOMIC MOLECULES. Devienne, F. Marcel (Laboratoire de Physique Moleculaire des Hautes Energies, Peymeinade, France). Entropie; No. 30, 167-70(Nov-Dec 1969). (In French).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

The purpose of the research described in this communication was double: on one hand, to show the existence of the hydrogen triatomic molecule in molecular beams obtained by neutralizing by exchange of charge ions beams H_3^+ and, on the other hand, to study the stability, and particularly the ionization of this triatomic molecule. In order to establish a direct proof of the existence of these triatomic molecules of hydrogen in a molecular beam, obtained through the neutralization of exchange of charge H_3^+, we have carried out two series of experiments. The first consists in using a converging beams device: a triatomic hydrogen molecular beam and a helium ion beam of a similar speed are superposed over a length of 120 cm. The experiment shows that ions H_3^+ are obtained through an exchange of charge. The second series of experiments makes the main purpose of the research described here, in order not only to show the existence of the hydrogen triatomic molecules, but also to study the dissociation of these molecules when they undergo inelastic collisions with various target gases. (auth)

19763 THE EXPERIMENTAL INVESTIGATION OF SHORT-RANGE REPULSIVE FORCES BETWEEN ATOMS AND MOLECULES OF ATMOSPHERIC GASES. Belyaev, Yu. N.; Kamyshov, N. V.; Leonas, V. B.; Sermyagin, A. V. (Moscow State Univ.). Entropie; No. 30, 173-7(Nov-Dec 1969).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

Elastic scattering of fast (300 eV to 4000 eV) neutral beams for systems of atmospheric interest is discussed. Measurements of effective total scattering cross sections make it possible to determine the values of inverse-power potential parameters for the interaction energy range ~0.1 to 2 eV. Using these potentials, the

values of reduced collision integrals $\bar{\Omega}$ (l,s) have been calculated for the temperature range from 2000 to 10,000°K. (auth)

19764 STUDY OF HIGH-ENERGY ATOMIC AND MOLECULAR HYDROGEN BEAMS CREATED BY CHARGE EXCHANGE ON STEAM. Dagnac, Rene; Blanc, Daniel; Molina, Daniele (Univ., Toulouse). Entropie; No. 30, 177-80(Nov-Dec 1969). (In French).

From Symposium on High and Intermediate Energy Molecular Beams, Cannes, France. See CONF-690709.

A hydrogen ion beam (H_1^+, H_2^+, H_3^+) of energy between 1 keV and 50 keV strikes a steam target. By using the equilibrium fractions method the effective cross sections of charge exchange σ_{10} and of electron loss of σ_{01} were measured. The results obtained are compared to those inferred from the Massey adiabatic criterium. (auth)

19765 ELECTRON TRANSFER AND DETACHMENT IN COLLISIONS OF LOW-ENERGY NEGATIVE IONS WITH O_2. Bailey, T. L.; Mahadevan, P. (Univ. of Florida, Gainesville). J. Chem. Phys.; 52: 179-90(1 Jan 1970).

Total cross sections for the production of slow heavy negative ions and of free electrons in collisions of O_2^-, O^-, OH^-, and H^- ions with O_2 molecules were measured over the primary-ion KE range from a few electron volts to 350 eV. The experiments are of the ion-beam gas-scattering type and utilize a radiofrequency filter to give separately the currents of detached electrons and slow product negative ions. The cross sections for slow ion formation, σ_t, were appreciable at all energies studied, for all four collision systems. The dominant contributions to σ_t could in most cases be attributed to simple charge transfer, although in the $H^- - O_2$ and $OH^- - O_2$ systems at low energies, the data indicate that ion–molecule reactions also contribute. With exception of the $H^- - O_2$ system, the electron detachment cross sections were similar in magnitude and in behavior with collision energy to those measured previously for other systems. (auth)

19766 HIGH-ENERGY ALKALI–RARE-GAS SCATTERING. Malerich, C. J.; Cross, R. J. Jr. (Yale Univ., New Haven). J. Chem. Phys.; 52: 386-92(1 Jan 1970).

Absolute total-collision cross sections in the lab energy range of 6 to 1000 eV were measured for several alkali-metal–rare gas systems — Na + Ar, Xe; K + Ne, Ar, Kr, Xe; and Cs + Kr, Xe. The limiting repulsive part of the intermolecular potential was described accurately by an inverse-power law Cr^{-s}, where s varied from 5.75 to 10.75 depending on the system. In the low-energy region the cross sections for the heavier systems show a pronounced rise due to the influence of the attractive part of the potential. In no cases could the cross sections be fitted by a two-term Lennard–Jones potential. A more abrupt transition is required between the inverse-power repulsion and the well region of the potential. (auth)

19767 ELECTRON DETACHMENT IN COLLISIONS OF O^-, OH^-, AND O_2^- IONS WITH RARE-GAS ATOMS. Wynn, M. J.; Martin, J. D.; Bailey, T. L. (Univ. of Florida, Gainesville). J. Chem. Phys.; 52: 191-7(1 Jan 1970).

Total cross sections for the electron detachment process $X^- + Y = e^- + X + Y$ were measured for the collision systems $O^- - He$, $O^- - Ne$, $O^- - Ar$, $O_2^- - He$, and $OH^- - He$ in ion-beam gas-scattering experiments which extend from primary ion energies of 400 eV down to several electron volts. Detached electrons were separated from other negative reaction products either by a radio-frequency electron filter, or by electrostatic-retardation analysis. Particular emphasis was placed on the low-energy region near detachment threshold; the data obtained in this region were found to conform fairly well to predictions of theoretical threshold laws. The cross sections obtained at higher energies are, for the most part, in good agreement with previous measurements. (auth)

19768 EXACT SEMICLASSICAL TRANSITION PROBABILITIES FOR COLLINEAR COLLISIONS. Locker, David J.; Wilson, David J. (Univ. of Rochester, N. Y.). J. Chem. Phys.; 52: 271-8 (1 Jan 1970).

The N-state semiclassical approach is used in the calculation of transition probabilities for atom–diatomic molecule collinear collisions. The diatomic molecule is allowed to oscillate during the generation of the classical trajectories. Comparisons are made with techniques in which the diatomic molecule is constrained to be nonoscillatory as the classical trajectories are traced out. The semiclassical method is extended to include diatomic–diatomic and atom–triatomic molecule collisions with use of the energy conservation equation. (auth)

19769 COHERENT ELASTIC X-RAY SCATTERING BY ATOMS. USE OF AN IMPROVED THOMAS–FERMI MODEL. Csavinszky, P. (TRW Systems, Redondo Beach, Calif.). J. Chem. Phys.; 52: 304-9(1 Jan 1970).

A recently obtained approximate variational solution of the Thomas–Fermi (TF) equation is used for the calculation of the total cross section of coherent elastic scattering of x rays by the noble-gas atoms. It is found that, apart from He and Ne, the calculated cross sections in the 1 to 1000 keV range agree within a few percent with the quantum-mechanical values. (auth)

Atomic Theory

Refer also to abstracts 20019, 20025, 20042, 20188, and 20222.

19770 QUANTUM AND CORRELATION CORRECTIONS TO THE THOMAS–FERMI POTENTIAL. Tietz, T.; Krzeminski, S. (Univ. of Lodz, Poland). Acta Phys. Acad. Sci. Hung.; 27: 161-8(1969).

The correction to the Thomas–Fermi potential arising from the exchange, inhomogeneity, and correlation effects is discussed. The Baraff equation and the approximation solution of the Thomas–Fermi equation for free neutral atoms given by one of the authors are used in considering the low- and high-density approximation. It is found that the main contribution to the solution of the Baraff equation arises from the inhomogeneity, screening, and exchange terms. (auth)

19771 NEW FOUNDATIONS FOR THE THOMAS–FERMI MODEL. Gaspar, R. (Kossuth Lajos Univ., Debrecen, Hungary. Research Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 27: 441-8(1969).

It is demonstrated that the atomic model, in which the zero-order approximations to the one-electron orbitals are hydrogen-like orbitals, always leads to a model that imitates very closely the Thomas–Fermi model of the statistical theory of the atoms. (auth)

19772 INTERPRETATION OF THE HARTREE–FOCK METHOD AS THE METHOD OF PARTIAL SUMMATION OF ATOMIC FEYNMAN DIAGRAMS. Tolmachev, V. V. (Univ. of Chile, Santiago). Acta Phys. Acad. Sci. Hung.; 27: 351-71 (1969). (In Russian).

The Hartree–Fock method is now the basis for almost all numerical calculations of characteristics of atomic and molecular states. So its interpretation as the method of partial summation of some class of atomic Feynman diagrams is very important. This interpretation permits an understanding of the sense of approximation inherent in the Hartree–Fock method and also the reasons for its peculiar effectiveness realized, for example, in calculations of ground states of light atoms. As a result the different theories of electronic correlations can be constructed more thoughtfully on the basis of the Hartree–Fock method. (auth)

19773 FURTHER NOTE ON THE SADDLE-POINT CHARACTER OF HARTREE–FOCK WAVE FUNCTIONS. Coulson, C. A. (Mathematical Inst., Oxford). Acta Phys. Acad. Sci. Hung.; 27: 345-9(1969).

A simple argument is provided to show that the energy of a Hartree–Fock wave function is a saddle point on the energy surface obtained by "opening-out" each pair of electrons from the same orbital w_j into two different orbitals u_j and v_j. A discussion is also given of the best direction in which to move away from the saddle point in order to lower the energy as rapidly as possible. The argument applies quite generally to atoms or to molecules, and both when using a finite basis (LCAO type functions) and when using an infinite basis (true Hartree–Fock functions). (auth)

19774 MOLECULAR PLASMONS: A GENERATOR COORDINATE TREATMENT WITH APPLICATION TO ATOMIC HELIUM AND HYDROGEN. Mehringer, Wolfgang. Z; Phys.; 231: 357-61(1970).

A method of calculation for the energy of the plasmon modes of a closed-shell molecular system is derived. The displacements s_j of Hartree–Fock one-electron functions are used as generator coordinates. The theory is applied to atomic helium and hydrogen. (auth)

19775 MODEL OF STEPWISE COULOMB POTENTIAL AND PERTURBATION THEORY. Gutman, I. I.; Bezpal'ko, R. M. (Odessa Technological Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 137-8(1969). (In Russian).

A model potential is proposed for an electron in an atom. The eigenfunctions for the one-electron Hamiltonian constructed on the basis of this model potential are suggested as the basic system of wave functions in perturbation theory. The suggested system of functions is as simple as the hydrogen system and deviates only slightly from the precision of the Hartree–Fock functions. The model potential is identical for all electrons of an atom. Results

of first-order calculations for Li($1s^2 2s$), Li($1s^2 2p$), Ne($1s^2 2s^2 2p^6$), and Na^+($1s^2 2s^2 2p^6$) are tabulated. Calculations of the ground-state energy of Be made by the suggested method are compared with calculations based on Hartree–Fock and hydrogen functions. The deviation does not exceed ~0.4%. The advantage of the method is that it can be used for second-order calculations. (R.V.J.)

19776 PROBLEM OF DENSITY OF THE BOUNDARY OF THE THOMAS–FERMI ATOM. Gessel, M. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 66-9(Nov 1968). (In Russian).

The Thomas–Fermi approximation is considered in the operator form. It is shown that the distribution function f in the case of a homogeneous system with exchange taken into account has the form $f(p) = \theta(p_0^2 - p^2)$ (p_0 is the Fermi momentum and θ is the step function) and that the density at the boundary of a free atom or ion, when one takes into account corrections of higher order, does not tend to the value obtained in the Hartree–Fock approximation. (auth)

19777 ENERGY LEVELS OF HIGHLY IONIZED ATOMS IN HYDROGEN-LIKE MODEL. Pavinskii, P. P.; Sherstyuk, A. I. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 11-19(Nov 1968). (In Russian).

A method for computation of energy levels of highly ionized atoms with one optical electron is proposed. The method is based on the general scheme of quantum mechanical calculations with the hydrogen wave functions. The hydrogen-like model for closed n-shells is used both for approximate treatment of the ion core electron density and for the potential. The model is generalized in this work to include the cores consisting of arbitrary sets of l-shells. Some numerical values of the parameters are quoted in the table. (auth)

19778 SELF-CONSISTENT CALCULATION OF EXCITED ^1P-STATE WAVE FUNCTIONS OF ATOMS. Mukherjee, P. K.; Sengupta, S.; Mukherji, A. (Saha Inst. of Nuclear Physics, Calcutta). Int. J. Quant. Chem.; 4: 139-47(Mar 1970).

In an earlier paper it was shown that approximate representations of excited states of atoms can be obtained from the study of the singularities in the dynamic polarizability. Starting with these wave functions a more accurate calculation of the excited states in the Hartree–Fock scheme can be made by a perturbation treatment. The resulting wave functions yield significantly improved energy values. The 2^1P, 3^1P, and 4^1P states of the He sequence up to C^{4+} are studied. The expectation values of a number of operators are calculated. The results obtained by the present method compare favorably with other elaborate calculations. (auth)

19779 BILINEAR ORBITAL EXPANSION OF GEMINAL-PRODUCT CORRELATED WAVEFUNCTIONS. Silver, David M. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 52: 299-303(1 Jan 1970).

Bilinear orbital expansions of geminals are proposed for use in forming a total electronic wave function from a single antisymmetrized product of geminals. This gives rise to a more general analytical form for the wave function than that represented by the previously discussed interacting, separated, or identical geminal models. Variational determinations of the geminals are enhanced by this more general scheme although additional algebraic complexities arise as well. Explicit expressions are given for the geminal expansions, density matrices, energy, and variational equations in the case of two singlet pairs of electrons. (auth)

19780 GROUND STATE OF HELIUM-LIKE SYSTEMS. Tietz, T. (Univ. of Lodz, Poland). J. Chem. Phys.; 52: 460-1(1 Jan 1970).

A simple approximate wave function for the ground state of two-electron systems, based on Slater and Hulthen orbitals, is suggested. Comparison of results for H^- with results of other methods indicates that accuracy is satisfactory for practical calculations. (A.G.W.)

Cosmic Radiation

Refer also to abstracts 19202, 19670, 20062, 20074, and 20272.

19781 MULTIPLE "COMPTON" ENERGY LOSSES OF ENERGETIC ELECTRONS AND THEIR POSSIBLE ROLE IN DIFFERENT COSMIC OBJECTS. Getmantsev, G. G.; Tokarev, Yu. V. Izv. Vyssh. Ucheb. Zaved., Radiofiz., 12: 624-5(1969). (In Russian).

Compton-energy losses in various cosmic objects during fast electron interactions with relatively soft photons are recurrent in character due to their proportionality to electromagnetic field energy, which in turn depends on the Compton losses of the total source electrons, and is a function of time. Calculations of multiple Compton energy losses and their effects were made, considering that the cosmic body has a spherical shape and equal fast electron and electromagnetic radiation density throughout the source. Data obtained showed that the main energy is emitted from the source as γ rays with quantum energy $\epsilon_\gamma \simeq mc^2(mc^2/E) \sim mc^2$. Thus, multiple Compton losses may be related to cosmic x and γ radiation sources. The examined mechanism of multiple component losses for monoenergetic electrons is a nonstationary case. The stationary case of consequent photon transformation due to the Compton losses was previously examined by M. J. Rees (Mon. Notic. Roy. Astron. Soc., 137: 429(1967)). (R.V.J.)

19782 PULSARS AS POSSIBLE SOURCES OF SUPERHEAVY NUCLEI IN THE PRIMARY COSMIC RADIATION. Silvestro, G. (CNR, Turin. Univ., Turin). Lett Nuovo Cim.; 2: 771-2(1 Dec 1969).

Superheavy nuclei ($Z \sim 110$) have been recently discovered in the primary cosmic radiation. It is suggested that pulsars may be the source of the superheavy nuclei observed in cosmic rays and the processes of formation and ejection of superheavy elements from such objects are discussed. (M.H.R.)

19783 COSMIC ELECTRONS AND DIFFUSE GALACTIC X AND γ RADIATION. Rees, M. J.; Silk, J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 3: 452-4 (Dec 1969).

It is suggested that the γ rays detected by Clark, Garmire, and Kraushaar at ~100 MeV may be due to the bremsstrahlung of cosmic-ray electrons in the interstellar medium. A diffuse galactic x-ray flux is predicted, produced by inverse Compton scattering of starlight photons with these electrons. Further consequences are discussed. (auth)

19784 INELASTICITY EFFECT ON LONGITUDINAL DEVELOPMENT OF ELECTRON AND HADRON COMPONENTS IN EXTENSIVE AIR SHOWERS. Cachon, Andre (Observatoire du Pic-du-Midi, Bagneres-de-Bigorre, France); Capdevielle, Jean-Noeel; Dupuy, Jean. Compt. Rend., Ser. B, 270: 234-7(19 Jan 1970). (In French).

In addition to the inelasticity effect, the method of simulation of extensive air showers gives the variation at sea level of electron, hadron and muon numbers for primary particle energies between 10^{13} and 10^{21} eV, and the variation of the relative abundance of muons with the nature of this particle. (France)

19785 SEARCH FOR FRACTIONALLY CHARGED PARTICLES IN COSMIC RAYS. Krider, Edmund Philip. Tucson, Ariz.; Univ. of Arizona (1969). 39p.

Thesis.

A scintillation counter telescope consisting of six scintillation counters and four wide-gap spark chambers was arranged to detect single particles with charge $\pm e/3$ or $\pm 2e/3$ which might be present in the cosmic radiation near sea level. Upper limits to the vertical intensities of such particles are 6.8×10^{-11} cm^{-2} sec^{-1} sr^{-1} for charge $\pm e/3$ and 1.2×10^{-10} cm^{-2} sec^{-1} sr^{-1} for charge $\pm 2e/3$ at a 90% confidence level. (Diss. Abstr. Int., B)

19786 A STUDY OF COSMIC-RAY MUONS AT DEPTHS LESS THAN 1000 FT UNDERWATER IN LAKE CHELAN, WASHINGTON. Learned, John Gregory. St. Louis; Univ. of Washington (1969). 142p.

Thesis.

An experiment was conducted underwater studying the depth and angular variations of the cosmic-ray muon flux, at depths of 0 to 1000 ft, and from uplooking to downlooking in angle. The data accumulated during 1967 using a Cherenkov-scintillation counter telescope are consistent with current theory and equivalent measurements under rock. Some data on muon pairs were also acquired and agree with expectations from extensive air shower results. While demonstrating the feasibility of detecting particles by their Cherenkov radiation in lake water, this experiment points the way towards further underwater research, at greater depths, and on a large scale. (Diss. Abstr. Int., B)

19787 PULSARS AND COSMIC RAYS. Fenton, A. G. (Univ. of Tasmania, Hobart, Australia). Proc. Astron. Soc. Aust.; 1: 285-6(Sep 1969).

Theories on the origin of cosmic rays are compared. (Australia)

19788 RECENT EVIDENCE CONCERNING THE SIDEREAL ANISOTROPY IN THE CHARGED PRIMARY COSMIC RADIATION. Jacklyn, R. M.; Vrana, A. (Dept. of Supply, Melbourne). Proc. Astron. Soc. Aust.; 1: 278-80(Sep 1969).

Three different experimental projects, involving observations with inclined meson telescopes at sea level, are compared, with particular reference to measurements obtained from the high-

zenith-angle experiment conducted on the Geiger-counter telescope at Mawson. (Australia)

19789 DIFFUSION OF COSMIC RAYS. Skilling, J. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 147: 1-12(1970).

Micro-instabilities are shown to play a dominant role in the diffusion of cosmic rays through the interstellar plasma. Some implications of this are considered, including possible explanations for the 'break' in the cosmic-ray energy spectrum at around 10^{15} eV, and for the 'two-component' model. (auth)

19790 DETERMINATION OF THE SOLAR-FLARE COSMIC-RAY RIGIDITY SPECTRUM USING THE WORLDWIDE NEUTRON MONITOR NETWORK. Palmeira, R. A. R.; Bukata, R. P.; Gronstal, P. T. (Univ. of Texas, Dallas). Can. J. Phys.; 48: 419-31(15 Feb 1970).

The determination of the rigidity spectrum of solar-flare produced cosmic rays is examined. A method based on the ratio of relative enhancements observed at two stations sufficiently separated in latitude is discussed, and graphs are presented showing the expected ratio of enhancements as a function of the spectral exponent of the flare-produced cosmic rays for 6 pairs of stations. This method, which assumes that the cosmic-ray particles arrive at the earth isotropically, is then applied to the 28 January 1967 event during which this condition of isotropy is shown to exist. An extension of this method to the case of anisotropic arrival of solar cosmic-ray particles using the concept of variational coefficient is outlined. (auth) (Canada)

19791 MONTE CARLO STUDIES ON THE ELECTROMAGNETIC COMPONENT OF EXTENSIVE AIR SHOWERS. Thielheim, K. O.; Beiersdorf, R. (Univ., Kiel). J. Phys., A (London); 3: 79-88(Jan 1970).

On the basis of three-dimensional Monte Carlo simulations on the hadronic component of extensive air showers the electromagnetic component of extensive air showers has been investigated theoretically, using approximative electromagnetic cascade theory. Results include the relation between mean total electron number and primary energy as well as mean lateral distribution of electrons. Fluctuations of parameters of the structure function, central density, and width of density distribution in sets of showers with given initial conditions are presented and found to be strong. The origin of observed deviations of electron density distribution from uniformity and axial symmetry is investigated with the help of calculated electron density matrices, the elements of which are electron numbers in squares of 10 cm × 10 cm. It is found that contributions to such fluctuations due to the influence of primary mass number on the development of the hadronic component are small in comparison with contributions originating from fluctuations in the development of the electromagnetic cascades or from fluctuations connected with the detection of particles. Therefore, it is concluded that, under conventional assumptions concerning nuclear interaction parameters, there is no possibility of inferring primary composition from observed multi-core structures in the electromagnetic component for vertical incidence of showers and for observations at sea level. (auth) (UK)

19792 MOMENTUM SPECTRA OF COSMIC-RAY PARTICLES AT SEA LEVEL IN THE MOMENTUM RANGE (0.5/6) GeV/c. Allkofer, O. C.; Knoblich, P. (Univ., Kiel). Lett. Nuovo Cim.; 3: 6-8(1 Jan 1970).

For studying cosmic-ray spectra at different atmospheric depths an apparatus consisting of a magnetic spectrograph and a calorimeter was constructed. A schematic diagram of the equipment is given which shows its dimensions and characteristic sizes. For testing purposes the momentum spectra at sea level were measured. (W.D.M.)

19793 COSMIC RAYS AND THE INTERSTELLAR MEDIUM. Fenton, K. B. (Univ. of Tasmania, Hobart, Australia). Proc. Astron. Soc. Aust.; 1: 269-72(Sep 1969).

Calculations outlined suggest that low-energy cosmic rays may maintain an electron density in the interstellar medium of $\sim 10^{-2}$ cm^{-3} in regions where acceleration is occurring. Refinements to the calculations appear unwarranted due to the present uncertainties in the flux of low-energy cosmic rays. (Australia)

19794 ORIGIN AND PROPAGATION OF COSMIC-RAY ELECTRONS. Berkey, G. B.; Shien, C. S. (Purdue Univ., Lafayette, Ind.). Phys. Rev.; 188: 1994-2010(25 Dec 1969).

The modulating of the energy spectrum of cosmic-ray electrons as they propagate in interstellar space is considered. The effects of spatial propagation, energy loss, boundary conditions, and the spatial distribution and energy spectrum of the electrons injected into interstellar space by the sources are all taken into account. Two models for spatial propagation are considered: isotropic diffusion and convection diffusion. In the latter, the particle motion parallel to the disk plane is characterized by diffusion, while particles are transported perpendicular to the disk plane by convection, caused by the outward expansion of the field lines. Examples are worked out for several source distributions. It is shown that the high-energy electron distribution (in both energy and space) is determined by the source distribution, rather than the properties of the confinement region (i.e., the propagation model). In order to illustrate how one can use the observable quantities (the electron spectrum and positron fraction at Earth, and the background Galactic radio and γ radiation) to determine the properties of the injection spectrum, we have considered the construction of a model of primary cosmic-ray electron sources in some detail. It is found that a combination of a source with a disk distribution and a source concentrated at the Galactic center may be necessary to explain the observed disk γ rays. (auth)

Direct Energy Conversion

Refer also to abstract 19501.

19795 (IPP-2/82) POSSIBLE STATIONARY POTENTIAL DISTRIBUTIONS OF A COLLISIONLESS TWO-EMITTER Cs-DIODE. Troppmann, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1969. 40p. Dep. CFSTI (U. S. Sales Only).

The Poisson equation together with boundary conditions suitable for a plasma diode with two equally heated emitter plates has been solved for stationary particle velocity distribution functions. The noncollision approximation is used and trapped particles are neglected. Overlapping of the ranges of existence of the different types of potential shapes and consequently an ambiguity of the mathematical solutions of the problem is found. Except for these regions the nonmonotonic potential shapes are uniquely determined by the boundary conditions in the case of ion-rich emission of both end plates. A shape characterized by monotonic potential variation within both sheaths results in this case. On the other hand, for electron-rich emission, two distinct shapes occur. One solution has an electron rich sheath in front of each emitter, the other one has a double sheath with its negative face nearest to the "negative" emitter at $-\xi_m$ and an electron sheath at the other plate. A criterion of stability is not given in the framework of this paper. However, the necessary additional condition $F(y) \geq 0$ ($F(y) \equiv$ square of the normalized electric field strength) reduces the number of ambiguous (mathematical) solutions of the problem. (auth)

19796 METHOD AND APPARATUS FOR THE DIRECT CONVERSION OF THERMAL TO ELECTRICAL ENERGY. Wilson, Vomey C. (to General Electric Co.). U. S. Patent 3,482,120. 2 Dec 1969. Filed 25 Nov 1957.

The system described for converting thermal to electric energy contains: a device having two conductive electrodes supported in closely spaced and insulated relation with the surfaces of the electrodes exposed to the interior of a vacuum tight enclosure; a reservoir communicating with the enclosure; a quantity of cesium in the reservoir; means of supplying heat to one of the conductive electrodes to maintain the temperature above 1400°K; means for maintaining the other of the electrodes at a temperature several hundred degrees K lower than the temperature of the first electrode; and means for maintaining the reservoir at a temperature substantially below the temperature of either of the electrodes. The hotter electrode is partially coated with cesium and the cooler electrode is completely coated with cesium, whereby the electron emission of the hotter electrode is enhanced by the partial coating of cesium and has a higher work function than the cooler one. Electrons emitted by the hotter electrode are collected by the cooler electrode and the difference between the work functions of said electrode surfaces provides a voltage for supplying current to an external circuit. The positive terminal of the device is provided by the warmer electrode and the cesium vapor between the electrode surfaces provides positive ions to neutralize the space charge within the device. (TSS)

19797 INTEGRAL CHARACTERISTICS OF MHD CHANNELS WITH NONCONDUCTING PARTITIONS. Lavrent'ev, I. V. Zh. Prikl. Mekh. Tekn. Fiz.; No. 6, 30-9(Nov-Dec 1969). (In Russian).

Electromagnetic characteristics of MHD channels with insulated walls, two sufficiently long electrodes, and insulating partitions were studied for the case of arbitrary magnetic field distribution along the channels. Special cases of specified magnetic fields and partition arrangements are discussed. (tr-auth)

19798 PROGRESS IN THERMIONIC CONVERSION STUDIES. Devin, B. (CEN, Saclay, France). Energ. Nucl. (Paris); 11: 552-6(Dec 1969). (In French).

The combined efforts of the C.E.A. and the D.R.M.E., with the assistance of Thomson-C.S.F., have led to the development of satisfactorily reliable thermionic converters. Prospects for the application of these thermodiodes to small autonomous nuclear reactors in the 100-kWek range are good. The effort is now being directed towards manufacturing methods and the cost price of these converters in significant quantities. European cooperation would be possible in the television satellite space reactor field. (auth)

Fluid Physics

19799 THE MECHANICAL ELECTROMAGNET AS A MODEL FOR THE MHD DYNAMO. Kirko, I. M. (Latvian State Univ., Riga). Dokl. Akad. Nauk SSSR; 188: 330-3(11 Sep 1969). (In Russian).

The term "MHD dynamo" designates a process in a moving conductive medium whereby an original magnetic field is increased as a result of the mechanical energy of the moving medium. Such a simple scheme, a mechanical electromagnet was studied as the means for the direct transformation of the mechanical energy into magnetic field energy. Following up M. Shteenbek's representation, the space was subdivided into an infinite number of conducting layers, moving in a certain plane within the magnetic field created by the induction of residual nonmagnetization. The results of the interaction of the layers in motion within the field were examined, establishing the conditions for the maximum efficiency of the MHD dynamo. A numerical example was given for steel sheets moving in a magnetic field. The problem of the maintenance of such a magnetic field consists in the compensation for the disruption of the field in the convicting medium by its directed motion, whereby the lines of force acquire a spiral shape. (TTT)

19800 GENERALIZATION OF THE POINCARE THEOREM IN MAGNETOFLUIDDYNAMICS. Zeuli, Tino. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 46: 561-8(May 1969). (In Italian).

Bounds are given in magnetohydrodynamics, for the angular velocity of a rotating fluid mass in relative equilibrium, from which follow some results given by Poincaré and Armellini. (auth)

19801 LAGRANGIAN EVOLUTION CRITERION IN MAGNETOHYDRODYNAMICS. Lebon, Georgy (Institut de Mathematique, Liege). Z. Angew. Math. Mech.; 48: No. 8 and Special Issue, T211-13(1968). (CONF-680469-1).

From Scientific Conference on Applied Mathematics and Mechanics, Prague, Czechoslovakia.

Prigogine (Introduction to Thermodynamics of Irreversible Processes, New York, Wiley (1961)) formulated an evolution criterion for dissipative irreversible processes stating that, under time-independent boundary conditions, the rate of entropy production within a given volume can only decrease when the fluxes are maintained constant. In this note, electromagnetic conducting fluids are considered, and, in particular, it is shown that Prigogine's principle remains valid for magnetohydrodynamic flow. (L.M.T.)

Geophysics (Upper Atmosphere)

Refer also to abstracts 19656, 19667, 19706, and 19894.

19802 (AD-695784) ELECTRON OBSERVATIONS BETWEEN THE INNER EDGE OF THE PLASMA SHEET AND THE PLASMASPHERE. Progress Report. Schield, M. A.; Frank, L. A. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Aug 1969. Contracts Nonr-1509(06); NAS5-2054. 47p. CFSTI.

The region between the inner edge of the plasma sheet and the plasmasphere was examined in detail. Only electron data acquired at low magnetic latitudes near local midnight are presented. (auth) (USGRDR)

19803 (N-70-12550) ELECTRON PARTICIPATION PATTERNS AND THEIR RELATION TO SUBSTORM INCREASES IN 50 TO 150-keV ELECTRONS AT THE SYNCHRONOUS ORBIT. Cosmic Ray Technical Report. Rosen, Lowell H. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Aug 1969. 42p. (NASA-CR-107162; CR-145). CFSTI.

Thesis.

Analysis of records from the seven-station Alaskan Riometer Chain (L = 3.9 to L = 8.) shows that the median latitude location of the hard (above 40 keV) electron precipitation region extends from a low-latitude edge (defined as maximum intensity/e) of L = 5 for all local times to a high-latitude edge of beyond L = 8 during the morning and to between L = 6 or 7 during the afternoon. With the aid of the riometer chain, the poleward and equatorward progression in precipitation onset was studied. The poleward progression events were most frequently seen near local midnight, and on the average, the time lag for the events showing the equatorward progression increased with local time between midnight and noon. Comparisons of the electron precipitation events at the riometer chain with increases of electron fluxes at the ATS-1 synchronous orbit show that a good correlation in coincidence, intensity, and latitude exists. The events used in this analysis indicate the source of much of substorm precipitation between 0400 and 1200 local time is an eastward-drifting, dribbling electron cloud. However, for some substorms, acceleration occurring at all local times is not ruled out. (auth) (STAR)

19804 POSSIBILITY OF INJECTION OF CHARGED PARTICLES INTO TRAPPED RADIATION ZONES DURING MAIN PHASES OF MAGNETIC STORMS. Shalimov, V. P. Kosm. Issled., 6: 941-3(Nov.-Dec. 1968). (In Russian).

Data on protons with energies greater than 200 eV and less than 50 keV can also be explained by particle injection during the main part of a magnetic storm. In this case only particles with small pitch angles can enter from a zone of quasi-captured radiation under conditions such that at high geomagnetic latitudes there exists a region in which the electric field has a westerly direction. This assumption is also necessary in order to explain the close correlation of DP perturbations and the energy of the annular current. The existence of a region with such a westerly electric field at high latitudes is possible with a particular configuration of the annular current causing the D_{st} variation. Estimates of the spiral electric field and the rate of particle displacement through the drift shells are given for a geomagnetic field having the structure of an annular current. The calculations show that at a distance of 1 to 2 earth radii from the current ring, which does not lie in the equatorial plane, a westerly electric field on the order of 1 to 2×10^{-6} volts/cm predominates. The particles can drift into this trap in about 10 hours. (TTT)

19805 HIGH-LATITUDE IONIZATION SPIKES OBSERVED BY POGO ION CHAMBER EXPERIMENT. McCoy, James Ernest. Houston, Tex.; Rice Univ. (1969). 92p.

Thesis.

The POGO spacecraft was launched into polar orbit October 14, 1965 and carried an ion chamber experiment sensitive to electrons with energies greater than 1 MeV and protons greater than 10 MeV. Data from this experiment were reduced and organized in the form of ionization plots vs. invariant latitude for individual orbits during the period October 14, 1965 to April 1, 1966. Ionization "spikes" appearing occasionally on these plots at high latitudes were studied in detail. It is shown that these spikes are present near the high-latitude boundary of stably trapped radiation on at least 30% of the satellite passes through this region. The occurrence of those spikes lying just inside the observed boundary of trapping appears to be evenly distributed with respect to local time, while the occurrence of spikes at latitudes outside the region of stable trapping is predominantly in the dawn hemisphere. The frequency of occurrence of all spikes increases markedly with increased magnetic disturbance. It is argued that these spikes are the result of injection of high-energy electrons ($E \sim 1$ MeV) onto field lines near the boundary of trapping and are associated with the electron "islands" reported in the magnetospheric tail by Anderson and others. The dynamics of expected charged-particle motion near the boundary of trapping are examined on the basis of the magnetosphere model proposed by Mead. It is shown that the spatial distribution of spikes as observed by POGO should be expected as a consequence of electron drift, in the post-midnight quadrant, into a region of pseudo-trapping. (Disser. Abstr.)

19806 ELECTRIC FIELD OF POLARIZATION IN THE IONIC POLAR EXOSPHERE. Lemaire, Joseph; Scherer, Marc (Institut d' Aeronomie Spatial de Belgique, Brussels). Compt. Rend., Ser. B; 269: 666-9(6 Oct 1969). (In French).

Considering the escape flux of positive and negative charges and electric quasi-neutrality of the milieu, it is shown that the Pannekoek and Rosseland electric potential is no longer applicable in the polar exosphere and that the average ion velocity is different from that of wind and polar-wind models. (tr-auth)

19807 CORRELATION BETWEEN THE INDICES R_{12} AND Φ_{F2} RELATIVE TO IONOSPHERIC PROPAGATION. Joachim, Miroslav; Kroupine, Youri (Comite Consultatif International des Radiocommunications, Geneva). Compt. Rend., Ser. B; 269: 664-5(6 Oct 1969). (In French).

A program for the analysis of the indices R_{12} and Φ_{F2} was pre-

pared. The values of these indices observed in the period from 1947 to 1969 are represented by three fourth-degree polynomials, the coefficients of which were calculated by the method of least squares. The data are analyzed to take into account a possible ionospheric hysteresis effect. The values of the coefficients of the three polynomials are given relative to ascending and descending phases, and the results are also represented graphically. It is shown that the hysteresis effect is insignificant, at least from a practical point of view. (J.F.P.)

19808 DESIGN OF A LONG-LIFE RELIABLE NUCLEAR EXPERIMENT FOR SPACE FLIGHT. Trainor, James H.; Williams, Donald J. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron., GE-7: 74-7 (Apr. 1969).

An experiment developed for flight on an Orbiting Geophysical Observatory in polar orbit (OGO-F) is described in which measurements will be made of the electron flux and spectra above 30 keV, both for precipitating and locally mirroring electrons as well as atmospheric backscatter. The scientific purposes, detector and electronic systems, packaging, thermal design, internal calibration, and test philosophy are discussed. The design features used in the development, fabrication and testing of the experiment, to ensure a long, useful lifetime in space, are emphasized. (BBB) (TSS)

19809 COMPARISON OF MEASURED AND CALCULATED OBLIQUE-INCIDENCE RADIO-WAVE PROPAGATION CHARACTERISTICS. Jones, T. B. (Univ. of Leicester, Eng.); Keenliside, W. Proc. Inst. Elec. Eng. (London); 117: 16-21(Jan 1970).

During the period from January to December 1966, measurements were made of the mode structure and absorption loss for high-frequency (hf) transmissions received over oblique propagation paths ranging in length from 500 to 1000 km. The propagation characteristics for these circuits were evaluated for the conditions appropriate to the period of observation by means of a ray-tracing analysis developed from the Booker quartic equation and also by two "prediction" methods. In general, the predicted values of absorption agree well with the experimental results, although some discrepancies occur during the winter months since neither of the prediction methods makes allowance for the anomalous winter behavior. The accuracies of the ray-tracing results are dependent on the validity of the assumed ionospheric model, and, when electron-density/height distributions derived from vertical-incidence soundings at the receiving site are employed, the ray-tracing calculations of mode structure and absorption loss are found to be consistent with experimental observations of these parameters. (auth) (UK)

19810 FIZIKO-TEKHNICHESKIE OSNOVY KOSMICHESKIKH ISSLEDOVANII. (Physico-Technical Principles of Space Research). Kroshkin, M. G. Moscow; Izdatel'stvo Mashinostroenie (1969). 288p.

This book covers physical characteristics of near-Earth and interplanetary space, and effects of cosmic radiation on the structural design of cosmic apparatus and on its material are discussed. Problems concerning electromagnetic solar radiation, earth and solar radiation fields, earth magnetic fields, corpuscular radiation, meteors in interplanetary space, and general physical characteristics of the Moon, Venus, and Mars are presented in the first section. The second section is concerned with cosmic radiation effects on materials and instrumentation of cosmic satellites considering the effects of meteor particles, electromagnetic and corpuscular radiation, and specific requirements demanded of electron devices exposed to strong radiation during cosmic flights. (R.V.J.)

19811 AURORAL-ZONE ELECTRON PRECIPITATION ASSOCIATED WITH ELECTRON BURSTS OBSERVED IN THE MAGNETOSPHERE AND THE MAGNETOTAIL. Pierson, John Donald. Houston, Tex.; Rice Univ. (1969). 127p.
Thesis.

On August 25–26, Vela satellites 3A and 4A were near the midnight meridian at geocentric distances of ~17.7 and ~18.2 R_E, when each detected bursts of energetic electrons and variations in the plasma properties which were subsequently related to bursts of energetic electrons sensed concurrently by the ATS-1 satellite and by instruments on a balloon at 1400 local time. There were negative magnetic bays on the Leirvogur and Sodankyla magnetograms during this event. Local magnetic time was approximately UT + 0 hours for Leirvogur, and UT + 3 hours for Sodankyla. The College magnetogram, UT + 10 hours, indicated essentially no magnetic bay activity. From a detailed study of this particularly complicated event several conclusions regarding the behavior of electrons in the magnetotail and in the magnetosphere were reached. (TSS) (Diss. Abstr. Int., B.)

19812 HEATING-GENERATED GRAVITY WAVES IN AURORAL ZONES. Testud, Jacques (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Compt. Rend., Ser. B; 270: 241-4(19 Jan 1970). (In French).

It is shown how heating in auroral zones may generate gravity waves propagated towards low latitudes. First results are in good agreement with experiments. These waves can contribute to thermosphere heating. (France)

19813 THEORETICAL INVESTIGATION OF CORPUSCULAR RADIATION EFFECTS ON THE F REGION OF THE IONOSPHERE. Torr, D. G.; Torr, Marsha R. (National Inst. for Telecommunications Research of the Council for Scientific and Industrial Research, Johannesburg). J. Atmos. Terrest. Phys.; 32: 15-34 (Jan 1970).

The importance of corpuscular radiation as a source of ionization in the ionosphere is investigated. In order to carry out this investigation quantitatively, the time-dependent ionospheric continuity equation is solved, taking into account production of ionization by solar extreme-ultraviolet and corpuscular radiation, loss by nonlinear recombination type processes, transport by plasma diffusion in an atmosphere which is in thermal nonequilibrium, and atmospheric winds. It is then shown, using laboratory measured values for the reaction rates and a midday electron flux of $\sim 10^9$ cm^{-2} sec^{-1} with an energy spectrum of the form exp $(-e_0/5)$, that ionization due to the low-energy electrons (0.05 to 2 keV) together with that due to euv radiation is able to account for the large observed daytime electron densities. Furthermore, it is shown that a flux of $\sim 5 \times 10^7$ cm^{-2} sec^{-1} is able to maintain the night F layer and that this diurnal variation in precipitated electron flux is entirely consistent with recent day and nightglow observations of the 3914 and 4278 Å bands. Fluxes of these magnitudes are also not inconsistent with recent rocket and satellite measurements. An assessment is made of the relative importance of atmospheric winds, and the early morning maximum in electron density observed at Sanae (70°S, 2°W) in Summer is discussed in the light of these phenomena. (auth) (UK)

19814 A METHOD FOR SIMULTANEOUS DETERMINATION OF ELECTRON CONCENTRATION AND ELECTRON COLLISION FREQUENCY IN A HOMOGENEOUS ISOTROPIC OR IN A SLOWLY CHANGING PLASMA. Muschler, W. (Max-Planck-Institut fuer Aeronomie, Lindau/Harz, Ger.). Z. Naturforsch.; 25a: 106-14 (Jan 1970). (In German).

A method is described, which allows determination of the complex refractive index of a plasma by separate measurement of the E and H component of an electromagnetic wave. By means of the complex refractive index simultaneously electron concentration and electron collision frequency of the medium can be stated. The measuring frequency depends upon absorption, precision requirements, and —for a locally varying medium —upon the availability range of theory used. General considerations are applied to a plasma model (terrestrial ionosphere without magnetic field). Simultaneous measurement of electron concentration and electron collision frequency should be well possible within a height range corresponding to the terrestrial D region. In higher regions determination of the (decreasing) electron collision frequency becomes more and more difficult, whereas possibilities for determination of the (increasing) electron concentration seem to improve. (auth)

19815 MHD RANKINE-HUGONIOT EQUATIONS APPLIED TO EARTH'S BOW SHOCK. Mihalov, J. D.; Sonett, C. P.; Wolfe, J. H. (Ames Research Center, Moffett Field, Calif.). J. Plasma Phys.; 3: 449-63(Sep 1969).

This paper compares computed results with upstream and downstream thermal pressures, and the downstream ion density and vector flow velocity measured by the Ames plasma probe on the Pioneer 6 spacecraft as Earth's bow shock was traversed. The upstream ion density and vector flow velocity measured on Pioneer 6 by this experiment are used as independent variables, together with Pioneer 6 magnetic field measurements. MHD Rankine–Hugoniot equations for an isotropic plasma are used for these computations. Reasonable agreement is obtained between the measured and computed downstream ion density, thermal pressure and convective velocity magnitude and orientation, only when a 1γ change is made to a downstream magnetic field value used in the calculation. There is disagreement between several determinations of shock orientation and that deduced from coplanarity of the reported magnetic fields, and the shock orientation provides the coordinate system for solving the Rankine–Hugoniot equations. If a shock orientation determined by velocity coplanarity is used in the calculations, all computed quantities agree well with the experimental results. Other results suggest that a disagreement between computed and measured upstream thermal pressures may not be

negligible in comparison with experimental uncertainties in upstream velocity and density. If the computations included anisotropic pressure terms and/or other factors such as plasma turbulence, better agreement might be obtained between computed and measured upstream thermal pressures. (auth) (UK)

19816 AURORAL OBSERVATIONS AT THE SOUTH POLE. Akasofu, S.-I. (Univ. of Alaska, College). Antarctic J. U. S.; 4: 229-30(Sep-Oct 1969).

Studies of the upper atmosphere phenomena which occur a little inside the auroral zone are described. The approximate location of the southern auroral oval at 16 UT, together with the location of the auroral zone, is shown. The uniqueness of the South Pole for auroral observations is that it is located near or under the auroral oval for most of the day (except for the few hours around midnight), whereas a typical auroral-zone station comes under the oval for only a few hours around midnight. All-sky photographs of auroras in the midday sector, taken on June 20, 1968 only several minutes apart, indicate that a single band has split into 2 bands, both of which show well-developed folds. There are many other types of activity associated with midday auroras. The South Pole moves under the auroral oval for several hours in the "dark" afternoon. Such a condition does not exist in any part of the U.S.A. or Canada (it does occur occasionally at the T–3 drifting station in the Artic Ocean). The South Pole films show a large number of surges traveling westward along the oval after being generated in the midnight sector during auroral substorms. Thus, the South Pole data are useful in elucidating auroral morphology along the oval in the afternoon sector, which is still poorly known. (BBB)

19817 RIOMETER OBSERVATIONS OF THE ANTARCTIC IONOSPHERE. Reid, G. C.; Hargreaves, J. K.; Ecklund, W. L.; Cowley, F. C. Antarctic J. U. S.; 4: 231(Sep-Oct 1969).

Continuous observations of ionospheric absorption events were carried out at Byrd, South Pole, and Vostok Stations, using riometers at frequencies of 30 and 50 MHz. Solar activity increased markedly over its relatively low level during the preceding year, and a considerable amount of data on polar-cap absorption (PCA) events was obtained. The 30-MHz absorption at 5 stations during both daytime and nighttime conditions in the ionosphere is illustrated. The difference between these two sets of observations is quite noticeable, and comparison with simultaneous satellite measurements of proton flux and spectrum indicates that atomic oxygen is of major importance in determining electron concentrations in the lower ionosphere. A detailed study of data obtained from the riometer system operated for two yr at Byrd and its magnetically conjugate station, Great Whale River, shows that the relative positions of event centers in the two hemispheres (which may be identified with conjugate points) vary seasonally over distances of the order of 100 km. This seasonal variation is insufficient, however, to explain the winter asymmetry in absorption between hemispheres. It appears likely that this asymmetry, which has a marked diurnal variation, is caused by a real difference in electron-precipitation intensity between the summer and winter hemispheres, although a seasonal variation in chemical composition of the lower ionosphere cannot be ruled out entirely. (BBB)

19818 AZIMUTHS OF AURORAL ARCS AT VOSTOK STATION DURING THE IQSY. Belousov, B. G. (Arctic and Antarctic Scientific Research Inst., Antarctica); Lukina, L. V.; Fel'dshtein, Ya. I. Sov. Antarct. Exped. Inform. Bull. (Engl. Transl.); 7: 120-2 (Dec 1969).

Analysis of photographic auroral observations at azimuthal angle $\Phi > 80°$ revealed that extended arcs and bands rotate 360° in the course of a day during the maximum of the solar activity cycle. Rotation is clockwise in the Northern Hemisphere (the azimuth increases from the geographic pole toward the east) and counterclockwise in the Southern Hemisphere. In 1965 at Vostok Station this pattern was traced during the minimum of the solar activity cycle. Azimuths of arcs with sharply outlined lower edges were measured. The closest point of an arc was removed from the zenith of the observer not more than by 60° (about 250 km for an auroral height of 150 km). Auroral brightness is low near the geomagnetic pole. Auroras appear suddenly and disappear suddenly near the zenith. The auroral azimuths change by 360° in the course of a day as they do during the maximum of the solar activity cycle. The arcs rotate more rapidly in the afternoon than they do after midnight. A similar pattern was observed during the IGY. The 1965 auroras were not oriented exactly along the direction toward the sun. The difference between the direction of auroras and the noon–midnight meridian varied within ± 20° in the course of the day. In the morning and evening, auroras were oriented approximately in the direction toward the sun, while around midnight they formed an angle of about 20° to the west and around noon, an angle of about 15° to the east of the direction of the moon–midnight meridian. It is concluded that during the IQSY auroral arcs in the polar region did not coincide with the direction of currents responsible for geomagnetic disturbances. The reason for this is that the distribution of auroral arcs in the direction toward the sun characterizes the geometry of the source of energetic electrons in the tail of the magnetosphere. At the same time, currents in the polar region in winter are mainly currents that reconnect from the oval auroral zone from the evening to the morning side of the earth. (BBB)

Low-Temperature Physics

Refer also to abstracts 19998, 20021, 20022, 20275, and 20279.

19819 ELECTRON TUNNELING INTO CHROMIUM SINGLE CRYSTALS. Shen, L. Y. L. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Appl. Phys.; 40: 5171-3(Dec 1969).

The conductance of Cr (single crystal)/Cr oxide/Pb tunnel junctions was measured as a function of bias voltage for (100) and (110) crystalline directions. Although the results are complicated by the presence of a large background conductance, the data support the existence of an antiferromagnetic energy gap in Cr at 1°K. (auth)

19820 COMMENTS ON ION MOBILITY IN VERY DILUTE SOLUTIONS OF ^{3}He IN ^{4}He AT LOW TEMPERATURES. Springett, B. E. (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 1: 209-11(Jan 1970).

A realistic model potential is used to explain the low-temperature low-concentration positive-ion mobility. It is suggested that a similar potential could explain the negative-ion mobility. (auth)

19821 EFFECTS OF LEAD ALLOYING ON THE ELECTRICAL RESISTIVITY ANISOTROPY AND SUPERCONDUCTING CRITICAL FIELD CURVE OF INDIUM. Carriker, Roy Cameron. Storrs, Conn.; Univ. of Connecticut (1969). 211p.

Thesis.

Approximately 110 indium specimens with 0 to 9 at.% lead were prepared, 85% as single crystals and 15% as polycrystals. Of these, 96 were of sample quality and had measurements made on them. The electrical resistivities at 4.2, 77, and 273°K were measured. The orientations of the single-crystal samples were determined, yielding the electrical resistivity anisotropies; a(4.2), a(77), and a(273), where $a \equiv \rho_\perp/\rho_\parallel$ (directions referred to the c-axis). The anisotropies of the temperature-dependent resistivities ($\rho_{77} - \rho_{4.2}$) and ($\rho_{273} - \rho_{4.2}$) were also determined. Using the ac field method, T_c was measured for the 0 to 4 at. % lead samples, and the critical field curves of the 0 to 0.8 at. % lead samples were studied. For pure indium it is found that $a(77) = 0.988 \pm .003$ and $a(273) = 1.037 \pm .003$, yielding the remarkable result that the direction of maximum resistivity changes from the c to the a direction as the temperature is increased from 77 to 273°K. A satisfactory explanation of this effect is found using the resistivity anisotropy model of Klemens, Van Baarle, and Gorter. As the lead alloying is increased from 3 to 9 at. %, anomalous behavior in the resistivity anisotropy is observed in the regions of 3.5 and 7.0 at. % lead. These are traced to anomalous behavior in the resistivity along the a direction, and are interpreted as Fermi surface–Brillouin zone boundary interactions. The superconducting transition temperature T_c is found to increase linearly with doping in the 3 to 4 at. % lead concentration range. This confirms earlier work and raises a question as to why there is no unusual behavior in T_c near 3.5 at. % lead when the other properties previously mentioned all exhibit some interesting behavior at this concentration. Critical field curve measurements in 0 to 0.8 at. % lead samples are found to qualitatively confirm the predictions of Clem for effects of alloying on the critical field curve of an anisotropic superconductor. Using the analysis of Clem, $\langle a^2 \rangle = 0.007$ is found from data on $[(dH/dT)c/T_c]$. The similarity conditions on $H_c(x)/T_c(x)$ and $h(x,t)$, where x is impurity content, are found to be violated for indium doped with lead. A linear effect in $H_c(x)$ which is stronger than the linear effect in $T_c(x)$ is also observed. (TSS) (Diss. Abstr. Int., B)

19822 HIGH-ENERGY NEUTRON–LIQUID ^{4}He SCATTERING AND THE ^{4}He CONDENSATE DENSITY. Puff, R. D.; Tenn, J. S. (Univ. of Washington, Seattle). Phys. Rev., A; 1: 125-32 (Jan 1970).

A simple theory of high-energy neutron scattering from liquid ^{4}He is developed. The inelastic scattering cross section for this process is related, for sufficiently high momentum transfer, to two parameters characterizing the ^{4}He momentum distribution. These two parameters are the average kinetic energy per particle and the fraction of particles in the zero-momentum condensate. Comparison of the theory with recent experimental data indicates that the condensate fraction ρ_0/ρ is approximately 0.06 at T = 1.27°K. (auth)

19823 NONLINEAR DIAMAGNETISM DUE TO THE FLUCTUATION SUPERCONDUCTIVITY. Tsuzuki, T.; Koyanagi, M. (Kyushu Univ., Fukuoka). Phys. Lett.; 30A: 545-6(29 Dec 1969).

Nonlinear susceptibility due to the fluctuation superconductivity is calculated microscopically in the Ginzburg–Landau–Gorkov approximation. The characteristic field of the nonlinearity is given by H_{c2}. (auth)

19824 FREQUENCY MEASUREMENT OF RADIATION FROM NORMAL-TO-SUPERCONDUCTING POINT CONTACT JUNCTIONS. Leopold, L.; Gregory, W. D.; Repici, D.; Averill, R. F. (Georgetown Univ., Washington, D. C. Contract F44620-68-C-0017. Phys. Lett.; 30A: 507-8(29 Dec 1969).

The frequency of radiation from Ta(superconducting)/Al(normal) point contacts was measured as a function of temperature. The dependence agrees with the Bardeen–Cooper–Schrieffer (BCS) gap equation for Ta. (auth)

19825 MICROSCOPIC THEORY OF QUANTUM FLUIDS. II. LAMBDA TRANSFORMATION. Mohling, F. (Univ. of Colorado, Boulder); Rama Rao, I.; Shea, Dion W. J. Phys. Rev., A; 1: 192-206(Jan 1970).

In a previous paper, the master-graph formulation of the quantum-statistical theory of quantum fluids was developed. If this formulation is used to calculate the equilibrium properties of quantum fluids, apparent divergences are encountered in the low-temperature limit. In the present paper, this theory is transformed by means of a Λ transformation to overcome these apparent low-temperature divergences. In this transformation, the terms in the theory which gave rise to the apparent low-temperature divergences and which represent the dominant low-temperature contributions are summed explicitly to obtain well-behaved expressions. In addition, a consistent method is developed to obtain the corrections to the dominant low-temperature contributions. Explicit expressions for the Λ-transformed theory are given for the cases of a Bose fluid above the Bose–Einstein condensation temperature and for a Fermi fluid. Finally, the physical implications of the Λ transformation are discussed. (auth)

19826 MICROSCOPIC THEORY OF QUANTUM FLUIDS. I. QUANTUM STATISTICAL DEVELOPMENT. Mohling, F. (Univ. of Colorado, Boulder); Rama Rao, I.; Shea, Dion W. J. Phys. Rev., A; 1: 177-92(Jan 1970).

A simplified derivation of the master-graph formulation of the quantum-statistical theory of an interacting quantum fluid is presented. A complete analysis of the self-energy structures arising from both particle statistics and particle interactions simplifies the master-graph expressions for the thermodynamic properties of the fluid. The x-ensemble formulation of Lee and Yang is used to treat the degenerate Bose fluid below its Bose–Einstein condensation temperature. The results for a Bose fluid above its Bose–Einstein condensation temperature and for a Fermi fluid are obtained as special cases. (auth)

19827 CRITICAL MAGNETIC FIELD PARALLEL TO THIN-FILM PURE SUPERCONDUCTORS. Dumoulin, Louis; Guyon, Etienne; Nedellec, Pierre (Laboratoire de Physique des Solides, Orsay, France). Compt. Rend., Ser. B; 269: 637-40(6 Oct 1969). (In French).

It is shown that it is possible even in relatively pure films to use critical superconducting properties for a study of the transport in the normal state. In addition, the first results of the appearance of a nonergodic behavior of pure superconductors in a high parallel field are presented. (tr-auth)

19828 INVESTIGATION OF THE FERMI SURFACE OF V_3Si BY MEANS OF POSITRON ANNIHILATION. Berko, S. (Brandeis Univ., Waltham, Mass.); Weger, M. Phys. Rev. Lett.; 24: 55-8 (12 Jan 1970).

Measurements of the angular correlation of annihilation radiation from oriented single crystals of V_3Si are reported, exhibiting marked anisotropies. These anisotropies are interpreted as hole pockets in the Fermi surface and are compared with the predictions of the linear chain model. (auth)

19829 MICROWAVE CONDUCTIVITY OF SUPERCONDUCTING THIN FILMS. D'Aiello, Robert V. Brooklyn; Polytechnic Inst. of Brooklyn (1969). 142p.
Thesis.

Microwave transmission at a frequency of 20 GHz through thin superconducting films of tin and granular aluminum was measured as a function of temperature as the films are cooled through their superconducting critical temperature (T_c). The measurements covered the temperature range from 4.2°K to 1.75°K. The experimentally measured quantities were, $|T_s/T_n|$, and $(\theta_s-\theta_n)$, respectively, the transmission amplitude and phase in the superconducting state relative to that in the normal state. By a suitable analysis, these quantities are related to the complex conductivity of the metal films. (TSS) (Disser. Abstr.)

19830 MAGNETIC PROPERTIES OF SUPERCONDUCTORS. Aston, Duane Ralph. Philadelphia; Temple Univ. (1969). 163p.
Thesis.

Experimental magnetization curves of superconductors are compared with existing theories. A series of measurements on PbIn alloys yielded the thermodynamic critical field H_c, the lower critical field H_{c1}, the upper critical field H_{c2}, the Ginzburg–Landau parameter k, the transition temperature T_c, the specific heat coefficient γ, and the normal-state resistivity ρ_N, as a function of temperature, alloy composition, specimen shape, and applied magnetic field. Discrepancies with theory have been noted. These are attributed to strong coupling and Fermi-surface effects not taken into account by existing theories. A study of spherical and cylindrical InBi alloy specimens in longitudinal and transverse magnetic fields has shown that it is possible to predict experimental H_{c1} peaks for impure, weak-coupling, alloys using geometrical demagnetization coefficients, if the magnetization curves are reversible. Agreement is found with an existing theory which predicts the dependence of the Ginzburg–Landau parameter k upon these coefficients. In this study, it was found that the Maki parameters K_1 and K_2 are equal at all impurity compositions of PbIn alloys, as well as In + Bi(3 at.%) at 4.2°K. This was established through reversible thermodynamic magnetization curves which resulted from sample jarring. A temperature-field dependent phase transformation has been discovered for both PbIn and InBi alloy specimens in which the sample underwent a transition from a Type I superconductor in the intermediate state to a Type II superconductor in the mixed state. Superheating effects were also observed in the PbIn alloy system. They strongly favor one of two current theories of superheating. Metastable phases have been observed in SnPb alloy specimens produced by a quick quenching technique. X ray analysis has shown that two phases exist which precipitate as a mixture of lead-rich and tin-rich laminae. Magnetization measurements have shown these phases produce a greatly enhanced upper critical field H_{c2}. (Disser. Abstr.)

19831 SUPERCONDUCTING AND MIXED-STATE SPECIFIC HEAT OF V_3Si. Brock, J. C. F. (Univ. of California, Berkeley). Solid State Commun.; 7: 1789-92(15 Dec 1969).

The superconducting specific heat of V_3Si shows a pronounced increase in lattice contribution below T_c and an anomalous electronic contribution. The mixed-state specific heat for $T \ll T_c$ contains terms linear and cubic in temperature, both of which are closely proportional to applied field. (auth) (UK)

19832 INFLUENCE OF OSCILLATORY MAGNETIC FIELDS ON THE NERNST EFFECT IN SUPERCONDUCTING LEAD FILMS. Huebener, R. P.; Rowe, V. A. (Argonne National Lab., Ill.). Solid State Commun.; 7: 1763-6(15 Dec 1969).

The Nernst effect in superconducting lead films of 3-μm thickness was studied in the presence of small oscillatory magnetic fields oriented parallel to the static magnetic field. An increase in the Nernst voltage and in the transport entropy per unit length and per unit flux was found due to the oscillatory field. In superconducting lead films, the influence of an oscillatory field on the Nernst voltage is similar to the influence on the resistive voltage. (auth) (UK)

19833 TIME-DEPENDENT GAP EQUATION FOR PURE SUPERCONDUCTORS. Leung, M. C. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 48: 598-602(1 Mar 1970).

The time-dependent gap equation is derived by including real scattering processes which are the essential causes of the fluctuations of the order parameter. (auth)

19834 A STUDY OF EVAPORATED SUPERCONDUCTING WEAK-LINK JUNCTIONS. Iwanyshyn, O.; Leslie, J. D.; Smith, H. J. T. (Univ. of Waterloo, Ont.). Can. J. Phys.; 48: 470-6(15 Feb 1970).

The current–voltage characteristics and voltage oscillations of evaporated, superconducting weak-link junctions were investigated. The zero-voltage current variation with temperature is shown to be similar to that for a Josephson junction. A simple theory based on part of the superconductor switching normal explains the voltage snapback. A model based on thermal instabilities due to bubbles in the liquid helium in contact with the junction is used to explain the voltage oscillations. (auth)

19835 PHOTOSENSITIVE TUNNELING IN SUPERCONDUCTIVITY. Radhakrishnan, V. (McGill Univ., Montreal). Can. J. Phys.; 48: 630-1(1 Mar 1970).

Theoretical treatment of the model proposed by Giaever for his experiment on the photosensitive tunneling in superconductors is examined. New relations are derived which connect the photoconductive property of the barrier and the tunneling current. These relations are helpful to check the model and to determine

the density of states for the trapped holes at the hole Fermi level. (auth)

19836 PARTIAL FLUX JUMPS IN SUPERCONDUCTOR TUBES. Urban, E. W. (Marshall Space Flight Center, Huntsville, Ala.). Cryogenics; 10: 62-4(Feb 1970).

Large flux jumps were observed to occur only in the outside of the wall of a tube of type-II superconductor, without travelling through to the tube bore. (auth) (UK)

19837 QUASI-PARTICLE TUNNELING IN Pb NEAR T_c. Vashishta, P.; Carbotte, J. P. (McMaster Univ., Hamilton, Ont.). Solid State Commun.; 8: 161-4(Feb. 1970).

New calculations are reported of the conductance of Pb tunneling junctions for temperatures T near the critical temperature T_c. Previous computations based on a model phonon spectrum for Pb predicted structure in this temperature range which is not observed experimentally. The study is based on the real phonon spectrum obtained by inversion of the Eliashberg equations according to the method of McMillan and Rowell. It is shown that this more accurate spectrum gives excellent agreement with the finite temperature data of Franck and Keeler. (auth) (UK)

19838 MICROWAVE-PHOTON-ASSISTED TUNNELING BETWEEN SUPERCONDUCTORS. Teller, S.; Kofoed, B. (Technical Univ. of Denmark, Lyngby). Solid State Commun.; 8: 235-8 (15 Feb 1970).

In the presence of microwave photons a series of current steps appears in the I-V characteristic for the tunnel current between two superconductors separated by an oxide layer. The magnitude of the current steps has been investigated as a function of the relative microwave power and a comparison to two existing theories give a rather good agreement with one of them. (auth) (UK)

19839 CONSIDERATION OF CRYSTAL STRUCTURE IN THE THEORY OF SUPERCONDUCTIVITY. Tareeva, E. E. (Inst. of High Pressure Physics, Moscow). Dokl. Akad. Nauk SSSR; 189: 299-301(11 Nov 1969). (In Russian).

The matrix element of the effective electron-electron interaction, resulting from exchange by phonons and responsible for the superconductivity of most metals, has been calculated previously. In the present work, the previously employed effective mass approximation is abandoned, considering instead the general case of strongly bound electrons when the one-particle energy is represented by a summation throughout the lattice of an invariant crystal group. Because of the invariance, the energy may be used as the variable. The Hamiltonian of the electron-phonon interaction, expressed in the second quantification representation was used by means of an orthogonalized function, deriving secular equations for excitation above the normal Fermi state. An expression was thus obtained to explain the creation of superconductivity. It is not necessary to be limited to cases of constant density at the Fermi surface. (TTT)

19840 AN INVESTIGATION INTO THE DEPENDENCE OF THE SUPERCONDUCTING ENERGY GAP ON THICKNESS IN THIN LEAD FILMS. Marchini, Robert Riggs. Clemson, S. C.; Clemson Univ. (1969). 80p.

Thesis.

The superconducting energy gap of lead was measured by the electron-tunneling method. The lead samples were in the form of vacuum deposited films. The dependence of the energy gap value on film thickness was then determined using a multiple-beam interferometer. The lead films were deposited in groups of five over either an aluminum-aluminum oxide film or a tin-tin oxide film. A shutter was used to vary the thickness of the films. After the energy gap measurements had been made, the substrate was removed from the cryostat and silvered prior to the thickness measurements. The data from the tunneling measurements was unusual in that an anomalous ohmic current appeared within the gap region. The gap measurements from this data ranged from 2.38 to 2.72 MeV. A definite dependence of the energy gap upon thickness was found. This dependence was found to qualitatively fit the curve predicted by Singh. Better agreement might have been obtained by plotting the energy gap as a function of the resistivity thickness of the films. It was also found that the anomalous ohmic current seemed to be best explained by assuming the edges of the lead films remained normal. This meant that the tunnel current as recorded was the sum of a normal tunnel current and a superconducting tunnel current from the same lead film. (Disser. Abstr.)

19841 ON SUPERCONDUCTIVITY IN SEMICONDUCTORS AND SEMIMETALS. Pashitskii, E. A. (Inst. of Physics, Kiev). Ukr. Fiz. Zh.; 14: 1882-9(Nov 1969). (In Russian).

The effect of interaction of conduction electrons with acoustic and longitudinal optical phonons is considered on the binding (correlation) energy of electronic Cooper pairs in degenerate semiconductors and semimetals with a plasmon mechanism of superconductivity. Competition between the process of Cooper pairing and formation of electron-hole pairs (excitons) in semiconductors is discussed. (auth)

19842 POSSIBLE FLOW-DEPENDENT TEMPERATURE GRADIENTS IN He FILMS. Huggins, Elisha R. (Dartmouth Coll., Hanover, N. H. Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 24: 573-6(16 Mar 1970).

Various experiments, especially recent experiments by Keller, clearly demonstrate that the thickness of a helium film is independent of the flow rate Q. This is consistent with the current picture of the hydrodynamics of a helium film if there are temperature gradients in the film which produce a thermodynamic potential $\varphi_T = \int SdT$ that cancels the $\rho_s v_f^2/2\rho$ term in the hydrodynamic potential μ. If such temperature gradients exist, they would produce unacceptably large evaporation rates unless the saturated vapor pressure p_{vap} is a function of μ rather than T. If $p_{vap} = p_{vap}(\mu)$, then there should be no thinning of the film with changes in Q, and the theory is in complete agreement with Keller's results. (auth)

19843 THICKNESS OF THE STATIC AND THE MOVING SATURATED He II FILM. Keller, W. E. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 24: 569-73(16 Mar 1970).

A three-terminal capacitor incorporated in a flow vessel was used to search for the theoretically predicted difference in the thickness Δd between the moving and the static saturated He II film. The observations indicate that $\Delta d = 0$ to within a few Å. (auth)

19844 X-RAY-DIFFRACTION STUDIES OF THE RELATIONSHIP BETWEEN DEFECT STRUCTURE AND SUPERCONDUCTING PROPERTIES IN NIOBIUM-TITANIUM ALLOYS. Penney, J.; Hoff, W. D.; Kitchingman, W. J. (Univ. of Manchester Inst. of Science and Tech., Eng.). J. Phys., D (London); 3: 125-30(Feb 1970).

The results of an x-ray line-broadening investigation of the effects of progressive deformation by rolling on two niobium-titanium alloys are reported and compared with similar measurements made on filed powders. The critical-current-critical-field superconducting properties of the same alloys are also reported as a function of deformation and heat treatment. Correlation of the x-ray-diffraction and superconducting results suggests that some improvement in superconducting properties after low-temperature post-deformation heat treatment can be associated with the initiation of a recovery process in the deformed alloy. The peak effect is observed in one of the alloys investigated. (auth) (UK)

19845 LOCALIZED EXCITATIONS IN A TYPE-I SUPERCONDUCTOR. Fullenbaum, Martin S. (Univ. of Virginia, Charlottesville). Solid State Commun.; 8: 21-2(Jan 1970).

The excitation spectra for localized surface states in a type-I superconductor are found by a series expansion method using the Bogolyubov equations. Results for the two lowest eigenvalues as a function of magnetic field are given. (auth) (UK)

19846 ELECTRICAL RESISTIVITY AND PEAK EFFECT IN SUPERCONDUCTING NIOBIUM. Huebener, R. P. (Argonne National Lab., Ill.); Kampwirth, R. T.; Seher, A. J. Low Temp. Phys.; 2: 113-19(Feb 1970).

The flux flow resistivity ρ_f has been measured in foils of high purity niobium as a function of magnetic field and temperature. The magnetic field dependence of ρ_f just below H_{c2} is much stronger than predicted by the recent theory of Maki for the pure limit. Near H_{c2} a peak in the critical current is observed that is independent of any voltage criterion. (auth)

19847 PROBLEM OF SUPERCONDUCTORS CONTAINING POLARIZED MAGNETIC IMPURITIES. Keller, J.; Benda, R. (Univ., Frankfurt am Main). J. Low Temp. Phys.; 2: 141-55 (Feb 1970).

The influence of impurity polarization on the superconducting transition temperature of superconductors containing magnetic impurities was investigated theoretically. From previous theoretical work it is known that the pair-breaking effect of magnetic impurities is reduced when the impurity spins are fixed by an internal field. This spin-dynamic effect is studied in detail on two models of the magnetic state of the system based on a mean field theory. In some cases the critical concentration of magnetic impurities that destroys superconductivity at T = 0 is increased, but it is found that the polarization energy of the magnetic impurities must be very large compared to the gap energy of the pure superconductor in order to increase the critical impurity concentration by the factor (S + 1)/S reported in the literature. It is con-

cluded that the anomalous dependence of the superconducting transition temperature on the concentration of magnetic impurities observed on some dilute alloys with rare-earth impurities can only be attributed to spin-dynamic effects if extraordinary strong polarizing forces between the magnetic impurities exist. (auth)

19848 SHOT NOISE IN JOSEPHSON POINT CONTACTS. Kanter, H.; Vernon, F. L. Jr. (Aerospace Corp., El Segundo, Calif.). Appl. Phys. Lett.; 16: 115-17(1 Feb 1970).

Experimental evidence is presented showing that the noise in Josephson point contacts is shot-noise-limited. Comparison with theory indicates that the pair current contribution is not as large as predicted. (auth)

19849 ANOMALOUS THERMAL CONDUCTIVITY IN SUPERCONDUCTING NIOBIUM. Carlson, J. R.; Satterthwaite, C. B. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 24: 461-4 (2 Mar 1970).

Anomalously high thermal conductivity of superconducting Nb between 0.3 and 0.6°K is interpreted as evidence for a small second energy gap. The temperature dependence of the excess thermal conductivity is consistent with a BCS-like gap about $1/25$ of the dominant gap in both magnitude and transition temperature. The magnitude of the excess conductivity appears to justify identifying the small gap with the hole sheet of the Fermi surface centered about symmetry point Γ. Less readily explained on the basis of a two-gap model are the high phonon conductivity observed in this and other experiments and the very high Q_s observed for Nb microwave cavities at low temperatures. (auth)

19850 CRITICAL TEMPERATURES OF SUPERCONDUCTING BINARY ALLOYS. Karaivanov, V. D. Vestn. Mosk. Univ., Ser. III, Fiz. Astron.; No. 5, 65-73(Sep-Oct 1969). (In Russian).

Studies were made of an isotropic superconductor with substitution-type intrinsic defects. It is shown that variations in electron–phonon interactions due to the difference of the defect and regular potentials resulted in a critical temperature. Green-function calculations were performed for low defect concentrations. (tr-auth)

19851 RARE EARTH IMPURITIES IN YB_6 AND ZrB_{12}. Fisk, Zachary; Matthias, Bernd T.; Corenzwit, E. (Univ. of California, San Diego, La Jolla. Bell Telephone Labs., Murray Hill, N. J.). Proc. Nat. Acad. Sci. U. S.; 64: 1151-4(Dec 1969).

Data on the depression of the superconducting transition temperatures of YB_6 and ZrB_{12} by rare earth impurities are given. The data show unusual features. For instance, Ce in YB_6 is in some ways analogous to Yb in ZrB_{12}, and this analogy also appears to hold between Ce in CeB_6 and Yb in YbB_{12}. (auth)

19852 FREQUENCY AND TIME-DOMAIN ANALYSIS OF SUPERCONDUCTIVE COAXIAL LINES. McCaa, William Donald Jr. Lawrence, Kan.; Univ. of Kansas (1969). 143p.

Thesis.

Methods and data for calculating the time and frequency responses of miniature superconductive coaxial transmission lines using the phenomenological Gorter–Casimir two-fluid model and the complete BCS theory were developed and applied to miniature 50-Ω lead–teflon–niobium lines. The calculated 10^4- to 10^{11}-Hz line attenuation and 1- to 100-psec step responses of an 80-foot coaxial line (Nb inner conductor 0.01 in. OD, teflon dielectric $\epsilon_r = 2.1$, Pb outer conductor 0.034 in. ID) are presented. These responses are presented over a temperature range of 2.3 through 10°K when using the two-fluid model, considering the anomalous and classical cases (with and without relaxation effects) for the normal conductor, and for a temperature of 4.24°K when using the BCS theory in its complete form. In addition, respectively using the two-fluid and BCS models, the 4.24°K, 1- through 8-GHz line attenuation of a 1360-foot line (Nb inner conductor 0.015 in. OD; teflon dielectric, Pb outer conductor, 0.051 in. ID) is calculated. Also, the 4.24°K, 1- through 100-psec step response of an 85-foot length of the same line is calculated. The frequency and time domain predictions by each model are compared with each other and with the experimental results of two independent investigators (2 through 10 db in this frequency range for the 1360-ft line and 50-psec 10 to 90% rise time for the 85 foot line). It was observed that: (1) the BCS theory responses fall quite close (within 6 db for the 1360-foot line and 20 psec for the 85 foot line) to those actually observed, (2) the two-fluid model in its two limiting forms provides reasonable bounds between which the experimental data will fall, (3) BCS responses fall close (within 1 db for the 1360-foot line) to those of the two-fluid anomalous case (the metal properties used in the BCS calculations were those of anomalous metals), and (4) the normal-state conductivity of the conductor must be very good if maximum bandwidths and minimum risetimes are to be obtained. The predictions neglected possible relatively small doses due to dielectric loss and flux trapping. Listings of the Fortran IV subroutines for calculating the surface impedance using the two-fluid model, and the complete BCS integral formulations are presented. BCS surface impedance plots, for relatively pure lead and niobium (mfp ≈ 5×10^{-5} m, $v_0 \approx 2 \times 10^5$ m/sec, $\xi_0 \approx 5 \times 10^{-8}$ m) at 4.24°K are given over a frequency range of 10^4 through 10^{11}. (Diss. Abstr.)

19853 SUPERFLUIDITY OF LOW-DENSITY FERMION SYSTEMS. Fay, Douglas Armstrong. Hoboken, N. J.; Stevens Inst. of Tech. (1969). 154p.

Thesis.

The superfluidity of low-density fermion systems is studied with emphasis on determining a criterion for the occurrence of the condensed state and the corresponding transition temperature. The BCS pairing assumption is employed in a form that admits hard-core interactions and pairing in states of orbital angular momentum greater than zero. A generalized integral equation for the energy gap is derived by field-theoretic techniques and shown, in the low density limit, to reduce to BCS form with the bare interparticle potential replaced by the complete irreducible interaction vertex for the scattering of the paired particles. A pairing interaction, U_l, related exponentially to the transition temperature, is defined for each l by a t-matrix-like integral equation. U must be negative for a transition to occur. The equation for U is solved by a linearized-perturbation procedure in which U is written as U^{BCS} plus a correction δU. This procedure is shown to be rigorous at low densities. Detailed calculation of U is carried out for a hard sphere gas and a delta-function model potential designed to simulate the repulsive core and attractive tail typical of the helium and nuclear potentials. The principal result is that, at sufficiently low density, for pairing in states with $l > 0$, the correction δU_l turns out to be attractive and can dominate over the BCS term. This is independent of the strength of the bare interparticle interaction and occurs because δU is second order in the density while U^{BCS} is order $2l + 1$. Thus, a system of hard spheres at low density and $T = 0$ should be in a condensed state with p-state pairing. Application to ^3He–^4He mixtures and the extension of the theory to the density range of ^3He are discussed. (Diss. Abstr.)

19854 CURRENT–VOLTAGE CHARACTERISTICS OF DISORDERED FILMS. Grassie, A. D. C.; Green, D. B. (Univ. of Sussex, Brighton, Eng.). Solid State Commun.; 8: 247-50 (15 Feb 1970).

Measurements were made of the critical currents of disordered aluminum films with thicknesses in the range 100 to 2000 Å, deposited upon liquid-helium-cooled substrates in such a way as to minimize edge effects. The observed current–voltage characteristics may be related qualitatively to the widths of the resistance–temperature and resistance–magnetic field transitions. (auth) (UK)

19855 CAPILLARY FLOW OF SUPERFLUID HELIUM AT 0.45°K. Chu, Tak-Kin. Hanover, N. H.; Dartmouth Coll. (1969). 126p.

Thesis.

The gravitational flow technique was used to study superfluid helium flow in glass capillaries with diameters between 0.020 and 0.25 cm and also with orifices in thin metal foil. The flow, initiated by a mechanical plunger, takes place between two concentric reservoirs, the inner one being a microwave resonant cavity. The resonant frequency changes linearly with the liquid level when the cavity is about half-filled with helium. A simple calibration allowed the cavity to be used as a sensitive liquid level detector. The smallest detectable level difference is 2×10^{-4} cm. The experiments were done at 0.45°K. At this temperature the effects of the normal fluid (mutual friction force, thermo-mechanical pressure, and viscosity) are small, so that the measured pressure difference at the ends of the capillaries can be attributed to a superfluid-boundary interaction force. It was found that the flow of superfluid in these experiments is essentially uniform over the cross section of the capillaries. The measured superfluid force is found to be a function of $(V - V_c)$: at low velocities, it is proportional to $(V - V_c)$, and at higher velocities, it varies approximately as $(V - V_c)^{1.7}$. This force is interpreted as due to a superfluid-boundary interaction, which depends on the geometry of the system and the nature of the boundary surface. The critical velocities are found to be weakly dependent on the channel diameter, following approximately the relation $V_c d^{\frac{1}{3}} = \frac{1}{3}$ in c.g.s. units. This dependence agrees better with the proposal by a group at Leiden than the calculation based on the simple Feynman-type vortex model. (Diss. Abstr.)

19856 MODEL OF A CLEAN SUPERCONDUCTOR CONTAINING A RANDOM ARRAY OF VORTICES. Cleary, Robert M. (Stanford Univ., Calif. Univ. of Illinois, Urbana). Phys. Rev., B; 1: 169-80(1 Jan 1970).

Equations for the Green's function and correlation functions of a

superconductor containing a random array of vortices are derived. These differ from the equations for a superconductor containing paramagnetic impurities inasmuch as here, the scattering potentials are macroscopic and cannot be treated in Born approximation. The scattering self-energy is approximated by the T matrix of scattering theory, which has been calculated elsewhere for real energies. In particular, the ultrasonic attenuation is derived for phonons of long wavelength ($ql \ll 1$) and low frequencies, at low vortex densities ($B/H_{c2} \ll 1$) near the critical temperature of the superconductor ($T \simeq T_c$). It is found that $a_\perp^{(1)}(T_c)$, the vortex cross section for ultrasonic attenuation of longitudinal waves propagating parallel to the vortex axis, equals 210 Å, which agrees well with the experimental result of 240 Å in vanadium. (auth)

19857 CONDITIONS FOR BOUND STATES IN A SUPERCONDUCTOR WITH A MAGNETIC IMPURITY. II. Fowler, Michael (Univ. of Virginia, Charlottesville); Maki, Kazumi Phys. Rev., B; 1: 181-8(1 Jan 1970).

The binding energy of the localized excitation at a magnetic impurity $JS\cdot\sigma$ in a superconductor is plotted as a function of J. The previous work is improved by including nonsingular terms in the solution to Suhl's scattering equations. These are found to alter the criteria for bound states significantly. The theory predicts that bound states deep in the gap will only occur for negative J of the order of magnitude of the superconducting coupling constant g. For J outside this range, any bound states will be very close to the gap edge, and the Abrikosov–Gor'kov theory should be satisfactory. (auth)

19858 SPECIFIC HEAT OF RHENIUM BETWEEN 0.15 AND 4.0 K. Smith, David R.; Keesom, P. H. (Purdue Univ., Lafayette, Ind.). Phys. Rev., B; 1: 188-92(1 Jan 1970).

The specific heat of rhenium was measured in the normal state between 0.15 and 4.0 K and in the superconducting state between 0.3 and 1.7 K. The specific heat in the normal state between 0.15 and 4.0 K was found to be $C_n = \gamma T + \alpha T^3 + A/T^2$, where $\gamma = 2290 \pm 20$ μJ/mole deg^2, $\alpha = 27 \pm 2$ μJ/mole deg^4, and $A = 49 \pm 2$ μJ deg/mole. Below $T_0 = 1.700$ K, the electronic contribution to the specific heat in the superconducting state was found to be $C_s = \gamma T_0 a e^{-bT_0/T}$, where $a = 8.14$ and $b = 1.413$. The above parameters were consistent with the vanishing of the entropy difference $S_n - S_s$ at T_0. The value of the Debye temperature at absolute zero, $\Theta_0 = 416$ K, agrees with the value derived from measurement of elastic constants. The density of states at the Fermi level, N (ξ), derived from the measured value of γ, is 0.484 states of one spin per eV atom. The value for the superconducting energy gap derived from the value of b deduced in this work is $3.43kT_0$, compared to a value of $3.30kT_0$ deduced from thermal-conductivity measurements. The critical-field parameter H_0 was found to be 211 Oe, and the deviation of the critical-field curve from parabolic dependence was less than 3.7%. The resonant frequencies corresponding to the interaction between the nuclear quadrupole moment and the crystalline field are estimated to be 41 and 82 MHz. (auth)

19859 EFFECT OF FLUCTUATIONS ON ELECTRONIC PROPERTIES ABOVE THE SUPERCONDUCTING TRANSITION. Abrahams, Elihu (Rutgers–The State Univ., New Brunswick, N. J.); Redi, Martha; Woo, James W. F. Phys. Rev., B; 1: 208-13(1 Jan 1970).

A calculation of the microscopic effects of the fluctuations of the superconducting order parameter in the classical region above T_c on the electron Green's function in dirty materials is presented. The calculation is formulated in the presence of a magnetic field. The results of this calculation in the zero-field limit are used to obtain the change in the thermal conductivity K and in the electron density of states $N(\omega)$. For a one-dimensional sample, K appears to diverge as $[(T - T_c)/T_c]^{-\frac{1}{2}}$ while for two and three dimensions, K depends weakly on temperature. The behavior of $N(\omega)$ is qualitatively similar to that of a gapless superconductor below its transition temperature, although the detailed frequency dependence is different. For thin films, the depression at the Fermi surface increases as $[(T - T_c)/T_c]^{-\frac{1}{2}}$. The agreement with experiment is satisfactory. (auth)

19860 STUDY OF FERMI-SURFACE TOPOLOGY CHANGES IN RHENIUM AND DILUTE Re SOLID SOLUTIONS FROM T_c MEASUREMENTS AT HIGH PRESSURE. Chu, C. W. (Bell Telephone Labs., Murray Hill, N. J.); Smith, T. F.; Gardner, W. E. Phys. Rev., B; 1: 214-21(1 Jan 1970).

The superconducting transition temperature was measured as a function of hydrostatic pressure up to 18 kbar for single-crystal and polycrystal samples of pure rhenium and dilute solid solutions of Mo, W, and Os in rhenium. The pressure dependence for pure Re is anomalous and varies rapidly with solute additions. This anomalous behavior is explained in terms of an abrupt change in Fermi-surface topology under pressure. (auth)

19861 PROXIMITY EFFECT OF SUPERCONDUCTORS IN HIGH MAGNETIC FIELDS. Fink, H. J.; Presson, A. G. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Phys. Rev., B; 1: 221-8(1 Jan 1970).

The nucleation field H_0 for superconductivity at the boundary between a normal and a superconducting semi-infinite half-space is calculated. At this field, for temperatures smaller than the transition temperature T_{cs} of the superconductor, a second-order phase transition occurs from the normal to the superconducting state as the magnetic field is decreased, and superconductivity is nucleated near the boundary between the superconducting and the normal metal. The calculation is general and is applied to clean and dirty superconductors. The normal metal also becomes a superconductor at a transition temperature $T_{cn} < T_{cs}$, and the above results apply to temperatures $T_{cn} \leq T \leq T_{cs}$ as well as $T < T_{cn}$, provided the Ginzburg–Landau equations apply. H_0 is temperature-dependent, and lies between the bulk nucleation field H_{c2} and the surface nucleation field H_{c3}. The value of H_0 depends on the Bardeen–Cooper–Schrieffer coherence lengths ξ_0, the mean free paths l in the normal states, the effective masses m, the electron densities n, and the transition temperatures T_c of both metals. For example, one finds, in the limit when both metals are dirty ($l \ll \xi_0$), that $H_{c2} \leq H_0 \leq H_{c3}$ for $0 \leq \sigma_s/\sigma_n \leq \infty$, where the σ's are the normal-state conductivities of the superconducting and the normal metal. This is not in agreement with previous calculations by Hurault, who concludes that when $\sigma_s/\sigma_n = 1$, the value of H_0 is H_{c2} for $T_{cn} \leq T \leq T_{cs}$. When $T < T_{cn}$, the value H_0 is strongly field- and temperature-dependent, particularly when $\sigma_s/\sigma_n \lesssim 1$. The above concept is applicable to internal boundary nucleation of superconductivity in the bulk of a superconductor. (auth)

19862 McMILLAN MODEL OF THE SUPERCONDUCTING PROXIMITY EFFECT FOR DILUTE MAGNETIC ALLOYS. Kaiser, A. B.; Zuckermann, M. J. (Imperial Coll. of Science and Tech., London). Phys. Rev., B; 1: 229-35(1 Jan 1970).

The tunneling model of McMillan for the proximity effect in normal-superconducting sandwiches is extended to the case when the normal metal film contains magnetic impurities. The excitation spectrum in each film and the superconducting transition temperature of the sandwich are calculated as functions of the impurity concentration and the film thickness. For a large range of impurity concentrations, the calculations predict that the density of states in both films is gapless, although the transition temperature of the sandwich is nonzero. The calculations are considered in relation to experiment, with reference to possible experimental probes for the Kondo effect in alloys that are nonsuperconducting in the bulk. (auth)

19863 MICROWAVE, FLUX FLOW, AND FLUCTUATION RESISTANCE OF DIRTY TYPE-II SUPERCONDUCTORS. Thompson, Richard S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., B; 1: 327-33(1 Jan 1970).

The recent theories by Caroli and Maki of the dynamic response of dirty superconductors were reexamined and found inconsistent and incomplete. Additional contributions, which were not included by them, are calculated, and new expressions are presented for the microwave and flux-flow resistance. In particular, it is found that the use of the time-dependent Ginzburg–Landau equation for the order parameter, coupled with the static Ginzburg–Landau equation for the current, is not generally adequate to calculate the leading superconducting contributions to the resistance. These results imply that the theory of Aslamazov and Larkin for the extra conductivity due to fluctuations above the transition temperature is also incomplete and that, in general, additional contributions of the type suggested by Maki must be included. (auth)

Plasma and Thermonuclear Physics

19864 ELECTROMAGNETIC PERTURBATION PRODUCED BY EXPANDING AN IDEALLY CONDUCTING SPHERE IN A MAGNETIC FIELD. Bodulinskii, V. K.; Medvedev, Yu. A. Zh. Prikl. Mekh. Tekn. Fiz.; No. 6, 102-4(Nov-Dec 1969). (In Russian).

Studies were made of electromagnetic perturbation produced during linear expansion of ideally conducting sphere in an external homogeneous magnetic field at a rate comparable to the speed of light. Field transition into a static state with a stopped sphere was also analyzed. (R.V.J.)

Confinement and Heating

19865 (IPP–6/78) ENERGY BALANCE EQUATION AND ENHANCED COLLISIONAL PLASMA DIFFUSION. Wimmel,

H. K. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1969. 24p. Dep. CFSTI (U. S. Sales Only).

An exact energy balance equation is derived from the first-order moments of the ion and electron transport equations. Thereby the particle loss of a stationary plasma through an isobaric surface is expressed as the sum of several terms each of which contains a specific force (E-field, collisional friction, anisotropic pressure including inertial terms). The equation provides a general frame of interpretation for any stationary diffusion process or loss mechanism of a plasma. In particular it is shown that Galeev–Sagdeev diffusion in an axisymmetric torus cannot be explained by the friction term $\eta_\perp j_\perp^2$ or the Joule term $E_\perp \cdot j_\perp$, but comes about by pressure anisotropy. This result rests on the assumption that the perpendicular resistivity $\eta_\perp$ is not altered in order of magnitude by the presence of trapped particles, an assumption that is plausible on account of recent work by Hinton and Oberman. For Tokamak-like parameters the effective pressure anisotropies required for explaining Galeev–Sagdeev diffusion are very small, of the order of 10^{-5} to 10^{-6}. (auth)

19866 (IPP-6/80) EFFECT OF INERTIA ON LOSSES FROM A PLASMA IN TOROIDAL EQUILIBRIUM. Zehrfeld, H. P.; Green, B. J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Sep 1969. 22p. Dep. CFSTI.

The MHD equilibrium of a resistive, low-density plasma was investigated in a model stellarator field. The effect of inertia on plasma motion is treated exactly, and its influence on plasma loss determined. The results are valid for arbitrary aspect ratio. For the existence of a stationary equilibrium, it is shown that there are two unconnected regions of solution, described in terms of the mass fluxes the long and the short way within a magnetic surface. Both these regions contain subregions corresponding to subsonic and supersonic fluid flow. For the region containing the case of the well-known classical resistive diffusion, it is argued that the increase in plasma loss due to inertia is strongly limited and does not appreciably exceed the classical diffusion rate. (auth)

19867 (MATT-Trans–100) STUDY OF PLASMA CONFINEMENT IN CIRCULAR l = 2 STELLARATORS. Rabinovich, M. S.; Shpigel, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Princeton Univ., N. J., from Preprint No. 171. 21p. Dep. CFSTI.

Properties of stellarators for computer simulation purposes are briefly discussed. The basic characteristics of the magnetic fields used for plasma confinement are described. Plasma data taken from the l = 2 stellarator are given. These include information on density, temperature, potential, electric fields, and magnetic fields. (M.O.W.)

19868 METHOD AND APPARATUS FOR INJECTING AND TRAPPING CHARGED PARTICLES IN A MAGNETIC FIELD. Bodner, Stephen E. (to United States Atomic Energy Commission). U. S. Patent 3,485,716. 23 Dec 1969.

A method and apparatus are described wherein an axial magnetic field having three spaced regions of increased field intensity defines first and second magnetic mirror containment zones between the first and second and second and third intensified field regions, respectively. Charged-particle ring bunches, e.g., of relativistic electrons, are created in the first zone and are transferred to the second zone by means of a pulsed magnetic field. In the second zone, the charged-particle bunch interacts with an ionized gaseous dielectric medium to emit Cherenkov radiation and thereby remove translational energy from the charged-particle bunch, which consequently is trapped to form a cylindrical particle sheath in the second zone. (AEC)

19869 OBSERVATION OF PLASMA NOISES IN CASE OF TURBULENT HEATING. Kalinin, Yu. G.; Lin, D. N.; Rudakov, L. I.; Ryutov, V. D.; Skoryupin, V. A. Dokl. Akad. Nauk SSSR; 189: 284-7(11 Nov 1969). (In Russian).

The authors found earlier that the turbulent heating of plasma by a direct discharge current is the result of ion–acoustic instability of the current. A magnetic probe with a 1-cm-diameter loop was used to observe the noise. The nonlinear transformation processes of the ion–acoustic waves excite an electromagnetic oscillation in the plasma with a wavelength of about 3 to 14 cm. This "whistle" may be accumulated in a plasma resonator. The experiments involved measurement of the diamagnetism in the heated plasma and oscillographic determination of the current and voltage through the plasma. A magnetic probe was used to measure the high-frequency oscillations during the turbulent heating. It was found that a two-fold increase of the discharge voltage from 16 to 21 kV results in a four-fold increase of the high-frequency energy density from 10^{-3} to 4×10^{-3} erg/cm^3, whereby the energy density of the heated plasma changed from 5×10^3 to 2×10^4 erg/cm^3. The data agree with theoretical predictions. The intensity of the noise may explain the anomalous resistivity of the plasma. (TTT)

19870 ELECTRON HEATING BY ELECTRON–ION BEAM INSTABILITIES. Davidson, R. C.; Krall, N. A.; Papadopoulos, K.; Shanny, R. (Univ. of Maryland, College Park. Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 24: 579-82(16 Mar 1970).

Rapid electron heating by two counterstreaming ion beams were observed in computer experiments. The results are compared with the predictions of quasi-linear theory and found to be in substantial agreement. (auth)

19871 EFFICIENCY OF CURRENT HEATING IN A DENSE PLASMA OF A STRONG CURRENT GAS DISCHARGE. Manzyuk, N. A.; Suprunenko, V. A.; Sukhomlin, E. A.; Ternopol, A. M. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 58: 551-7(Feb 1970). (In Russian).

The physical efficiency of current heating of a dense plasma in a strong-current gas discharge stabilized by a strong magnetic field is considered. The heating efficiency is of the order of 60%. Current heating is the result of successive development of a number of streaming instabilities and takes place as long as the current flows in the active region of the discharge. The value of the plasma thermal energy density previously obtained ($nkT = 3 \times 10^{16}$ eV/cm^3) is confirmed. (auth)

Diagnostics

19872 PERFORMANCE OF AN ELECTRODELESS CONDUCTIVITY PROBE IN ANISOTROPIC PLASMA. Savic, P.; Stock, F. T.; Goldman, T. J. (National Research Council of Canada, Ottawa). Can. J. Phys.; 46: 2595-2600(1 Dec 1968). (NRCC-10392).

Following the method of an earlier paper, Maxwell's equations for the magnetic field of a filamentary coil around an infinite circular cylinder of plasma under the action of an axial magnetic field were solved, and the resulting integral transforms representing the complex coil impedance evaluated on a digital computer. For experimental confirmation, a cylinder of phosphorus-doped silicon was used, with a short coil wound around it, and the impedance change of this was determined as a function of the applied axial magnetic field. These impedance changes were used to deduce values of longitudinal conductivity and Hall coefficients of the cylinder were determined, in agreement with estimated values for the solid core. (auth) (Canada)

19873 SPECTROSCOPICALLY MEASURED VELOCITY PROFILES OF AN MPD ARCJET. Beth, M.-U.; Kling, M. G. (Institut fuer Plasmadynamik, Stuttgart). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 7: 2181-2(Nov 1969).

The plasma jet was investigated with respect to the Doppler shift of spectral lines resulting from macroscopic velocities in axial and rotational directions. The plasma jet was generated by a continuous MPD arc thruster. The off-axis intensity of a spectral line was recorded and observed on an oscilloscope in order to secure reproducibility and no spoke mode operation. (M.O.W.)

19874 SENSITIVE MICROWAVE INTERFEROMETER FOR PLASMA DIAGNOSTICS. Wallington, J. R.; Beynon, J. D. E. (Univ. of Southampton, Eng.). J. Plasma Phys.; 3: 371-5(Sep 1969).

More accurate methods of measuring microwave attenuation and phase are constantly being sought, particularly for such applications as plasma diagnostics. The microwave bridge technique described here was developed for the study of a quiescent plasma having an electron density of 10^{15} to 10^{18} m^{-3} corresponding to a plasma frequency of 3×10^8 to 10^{10} Hz, and an electron collision frequency of 10^{10} to 10^{11} s^{-1}. The plasma had a broad dimension of 0.3 m. For such a plasma a probing frequency of 10 GHz was considered to be the most suitable; at this frequency the attenuation α and phase shift $\Delta\beta$ expected were $0.1 < \alpha < 50$ dB and $1° < \Delta\beta < 1000°$ respectively. (auth) (UK)

19875 SAMPLING SYSTEM TO DISPLAY VARYING FREQUENCY SHIFTS OF A RESONANT CAVITY CONTAINING PLASMA. Hugenholtz, C. A. J. (FOM-Instituut voor Plasma-Fysica, Jutphaas, Netherlands). J. Phys., E (London); 3: 318 (Apr 1970).

A well-known microwave method to measure electron densities is based on the effect that the resonance frequency of the cavity shifts due to the presence of plasma. Here, a method is described which can be applied to obtain a direct display of the frequency shift as a function of time in the case of varying plasma densities. (auth) (UK)

19876 A MINIATURE FIBRE OPTICS OBSERVATION SYSTEM FOR ENCLOSED PLASMA MACHINES. Evans, D. E.;

Pasco, I. K. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., E (London); 258-60(Apr 1970).

A miniature lens and image conduit assembly is described which permits the observation of radial luminosity distributions in cylindrically symmetric plasmas when the configuration of current-carrying conductors makes the plasma inaccessible to conventional high-speed photography techniques. Density profiles obtained with the assembly are indistinguishable from those measured by the usual method. (auth) (UK)

Kinetics (General)

19877 COMPARISON BETWEEN MEASURED AND THEORETICAL STARK-BROADENED PROFILES OF H_6–H_{12} EMITTED FROM A LOW-DENSITY PLASMA. Bengtson, Roger D. (Univ. of Texas, Austin); Tannich, J. D.; Kepple, P. Phys. Rev., A; 1: 532-3(Feb 1970).

Experimental profiles, theoretical Stark-broadened line profiles, and the asymptotic wing approximation of hydrogen Balmer lines H_6–H_{12} are compared at an electron density 1.2×10^{13} cm^{-3} and at a temperature of 1850°K. Theoretical line profiles are calculated using the impact approximation for electrons and quasistatic approximation for ions. The half-widths and $1/10$ widths agree to within mutual tolerances, and over-all qualitative agreement is excellent. (auth)

19878 THERMAL PROPERTIES OF A HELIUM–POTASSIUM PLASMA. Darrigo, Rene (Univ., Rouen. Institut National Superieur de Chimie Industrielle, Mont-Saint-Aignan (France). Compt. Rend., Ser. B; 270: 320-3(2 Feb 1970). (In French).

Mass transfers induced by contact with a cold wall are studied in a helium–potassium plasma. The properties are studied in relation to the temperature gradient. (France)

Kinetics (Experimental)

19879 (IPP–1/97) STATIONARY COLLISIONLESS SHOCK WAVES IN AN INITIAL PLASMA WITH HIGH ION TEMPERATURE. Kornherr, Manfred (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1969. 81p. (In German). Dep. CFSTI (U. S. Sales Only).

Stationary collisionless shock waves propagating perpendicularly to an initial magnetic field are produced by the fast-rising magnetic field ($\dot{B} = 7 \times 10^{10}$ G/sec) of a theta pinch (coil diameter 16 cm, coil length 60 cm). Strong collisionless dissipation can be demonstrated by measuring the profiles of magnetic field, electron density, and electron temperature of several shock waves. For the electrons this dissipation mechanism can be described by an effective collision frequency. This phenomenologically introduced frequency determines the width of the shock front at least for subcritical shock waves. It exceeds the classical electron–ion collision frequency by 1 to 2 orders of magnitude and is roughly equal to one-third of the ion plasma frequency. The ion temperature can be estimated from the steady state of freedom perpendicular to the magnetic field. For shock waves with Mach numbers below the critical one the ions seem to be heated merely adiabatically. In strong shock waves this heating is considerably exceeded, and for high Mach numbers it yields ion temperatures up to about 500 eV. Finally, formulas are derived to estimate the possible temperatures of electrons and ions behind the shock front. (auth)

19880 (ORNL-TM-2856) EXPLORATORY PLASMADYNAMIC STUDIES OF VORTEX AND COAXIAL FLOW GEOMETRIES EMPLOYING RADIO-FREQUENCY INDUCTION HEATING. Keyes, J. J. Jr.; Sartory, W. K. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 33p. Dep. CFSTI.

Experiments are described in which the effect of high-energy-density volumetric heating on jet-driven vortex flow of helium and argon were determined. A radio-frequency power source capable of 50-kW output in the range from 0.4 to 4.0 mHz was used to heat argon and helium–argon plasmas inductively at atmospheric pressure to peak temperatures estimated to be between 10,000 to 15,000°K depending on plasma composition. Experiments with 2-in.-diam by 6-in.-long water-cooled copper and quartz vortex tubes have revealed that significant increase in the ratio of tangential velocity to injection velocity above that measured at room temperature is effected when the argon gas is inductively heated to plasma conditions. Exit gas temperatures of up to 7000°K have been measured. (auth)

19881 TEMPERATURE DEPENDENCE OF THE THREE-BODY RECOMBINATION COEFFICIENT IN A HIGHLY IONIZED POTASSIUM PLASMA. Motley, R. W.; Jassby, D. L. (Princeton Univ., N. J.). Phys. Rev., A; 1: 265-9(Feb 1970).

Measurements of the volume recombination coefficient of a highly ionized potassium plasma demonstrate the strong inverse temperature dependence predicted theoretically, and provide further confirmation of the three-body nature of the recombination process. (auth)

19882 ELECTRIC CONDUCTIVITY OF XENON PLASMA. Bakeev, A. A.; Rovinskii, R. E. Teplofiz. Vys. Temp.; 8: 207-9(1970). (In Russian).

Electric conductance of xenon plasma was studied as a function of density of the discharge current. The relationship between the electric conductivity and temperature of the discharge in a thermal-equilibrium plasma was analyzed. It was assumed that plasma conductivity is constant across the discharge tube. The discharge temperature was obtained using the Saha formula based on interferometric measurements of charged- and neutral-particle concentrations and on the absolute measurements of plasma concentration and absorption. Data obtained show that at $p \geq 400$ mm Hg, the electric conductivity as a function of current density is described by empiric formula $\sigma = 0.885\ j^{\frac{1}{3}}$ (where σ is ohm$^{-1} \cdot$ cm^{-1} and j is A/cm^2). At p = 100 mm Hg, the conductivity is higher but the σ function of j is conserved. The data on xenon plasma conductivity as a function of the discharge temperature was inconclusive. (R.V.J.)

19883 SOME PARAMETERS OF PLASMA CLUSTERS GENERATED BY CONICAL THETA PINCH. Alinovskii, N. I.; Papyrin, A. N.; Pakhtusov, B. K.; Ponomarenko, A. G. Zh. Prikl. Mekh. Tekn. Fiz.; No. 6, 105-10(Nov-Dec 1969). (In Russian).

Studies of plasma clusters by various diagnostic methods revealed, in the front section of the cluster, the presence of (hydrogen) plasma without any impurities with electron temperatures of ≈30 eV. Behind was found plasma with a high content of neutral gas and (carbon and calcium) impurities. It was also found that the interactions between the discharge current with the walls of the chamber, influenced the formation of the latter part of the cluster. However, the use of a shorting discharge reduced this effect considerably. An attempt was made to determine the parameters of the cluster generated by the conical θ-pinch injector and to reduce plasma interactions with the walls of the discharge chamber by shorting the discharges. (R.V.J.)

19884 PARTICLE DIFFUSION IN A LOW-PRESSURE CROSS-FIELD PLASMA HEATING DEVICE. Rikoski, Richard A. (Univ. of Pennsylvania, Philadelphia); Young, Frederick J. Jap. J. Appl. Phys.; 9: 203-11(Feb 1970).

The Slepian-discharge rotating magnetoplasma is investigated in helium for neutral gas pressures of 3.3×10^{-1} and 6.7×10^{-2} torr with end wall potentials to +300 volts dc and an applied axial magnetic field of 0 to 6000 gauss. A cold cathode field emission Penning discharge radial ion source is incorporated within the apparatus as a central ion source. Ion and electron diffusion rates across and along the applied field lines are determined as functions of applied end wall potential, Penning discharge current and axial field strength. For pressures of 3.3×10^{-1} and 6.7×10^{-2} torr, anomalous increases in radial current with increasing magnetic field are not observed, while distinct minima in end wall currents are found suggesting a critical value of magnetic field strength after which the character of the particle flow to the end walls markedly changes. (auth)

19885 PROPAGATION OF HIGH-CURRENT BEAMS OF RELATIVISTIC ELECTRONS IN GASES. Andrews, M. L.; Davitian, H.; Hammer, D. A.; Fleischmann, H. H.; Nation, J. A.; Rostoker, N. (Cornell Univ., Ithaca, N. Y.). Appl. Phys. Lett.; 16: 98-100(1 Feb 1970).

The transit time of high-current beams of relativistic electrons (40 to 50 kA, 350 keV) through an air-filled (0.2 to 2.5 torr) drift tube was measured. It was longer than expected, even allowing for the loss of beam front electrons and for orbiting of the electrons in the beam self-magnetic field. Also, a pressure-dependent nonuniformity in the beam motion was observed that may account for this delay. (auth)

Kinetics (Theoretical)

19886 (JUL–617-TP) CALCULATION OF THE ELECTRIC CONDUCTIVITY OF A PLASMA WITH SPECIAL ATTENTION TO THE EXCITATION LOSS AND THE DIFFUSION OF THE CHARGE CARRIER. Holzapfel, Christian (Kernforschungsanlage, Juelich (West Germany). Institut fuer Technische Physik). Oct 1969. 70p. (In German). Dep. CFSTI (U. S. Sales Only).

A theoretical investigation was made of the influence of radiation and electron diffusion on the electric conductivity of an alkali

metal–rare gas plasma. The scalar electric conductivity of a plasma is given mainly by the electron density. If the electron temperature is high enough, the electron density is related to electron temperature by the Saha equation. Then the electron temperature is given by the balance of energy gain by current and energy loss by elastic collisions with the other plasma components. Moreover, two processes reduce the electron density. In the first place, the density of electrons is reduced directly by ambipolar diffusion of the charged particles out of the discharge volume. Secondly, the density of electrons decreases by the reduction of the electron temperature due to inelastic collisions or radiation. These two processes are important at low temperatures and in small geometries. Calculations are carried out in the case of a cesium–argon plasma. (auth)

19887 QUASI-STATIC THEORY OF AN IONIZED PLASMA MEDIUM WITH PARTIAL TRAPPING OF RADIATION. Peyraud, Nelly; Peyraud, Jean (Faculte des Sciences, Orsay, France). J. Phys. (Paris); 30: 773-88(Oct 1969). (In French).

A plasma free of any external field, partially ionized, optically thick for the first transition starting from the fundamental level (resonance radiation for hydrogen and alkali atoms) and optically thin for all other transitions is considered. Electron distribution function results from electron–electron collisions, inelastic electron impact on the fundamental level, and superelastic electron impact on resonance level. It is found that the distribution is Maxwellian for energies smaller than the first threshold ("body" of the function) but in general non-Maxwellian for higher energies ("tail" of the function). Electron equilibrium properties were studied, neglecting the slow variation of neutral temperature. The "temperature" of the "body" is calculated by an energy balance and is smaller than the neutral one. For a first study, resonance radiation is supposed to be confined in the plasma and this hypothesis is used to calculate the ratio between populations of fundamental and resonance levels. The theory is improved by including partial losses due to boundary effects. However, the "tail" of the distribution function is necessary to calculate those two parameters ("temperature" of the "body" and ratio of populations); equations are written for the "tail" which will be solved in a second paper. Numerical applicability conditions of the model used are discussed for atomic hydrogen case. (auth)

19888 PLASMA COLLECTIVE MODES INVOLVING GEOMETRY AND VELOCITY SPACES. Coppi, B. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-3980. Riv. Nuovo Cim.; 1: 357-402(Jul-Sep 1969).

The following topics are discussed: (1) two-dimensional initial state, (2) mode classification, (3) linearized Vlasov equation for lf modes, (4) fast (electron) modes, (5) resonant electron ballooning mode, (6) particle–wave resonances, (7) quasi-fluid electron drift mode, (8) resonant-electron flute mode, (9) quasi-fluid electron flute mode, (10) slow (ion) modes, (11) slow flute modes from the local magnetic curvature, (12) low-density ion flute modes, (13) slow fluid-like drift modes, (14) so-called trapped-particle modes, and (15) impurity-particle modes. (M.O.W.)

19889 INFLUENCE OF SEVERAL TYPES OF INELASTIC COLLISION ON THE ELECTRON ENERGY DISTRIBUTION IN HELIUM. Postma, A. J. (EURATOM–FOM, Jutphaas, Netherlands). Physica; 45: 609-18(26 Jan 1970).

Electron energy distribution functions were calculated for a discharge in helium at a reduced electric field strength 1000 V/m torr, taking into account the inelastic collisions of electrons with atoms in the ground state and with atoms excited in the states 2^3S, 2^1S, 2^3P, and 2^1P. It appears that especially the excitation of atoms in the state 2^3S to the state 2^3P has much influence on the distribution function. This is caused partly by the large concentration of atoms in the state 2^3S (compared with atoms excited in the other mentioned states) and partly by the large excitation cross section of this transition. (auth)

19890 BREMSSTRAHLUNG RADIATION IN PLASMAS. Papadopoulos, Konstantinos (Univ. of Maryland, College Park). Amer. J. Phys.; 38: 87-9(Jan 1970).

A new, short derivation of the radiation formulas from a homogeneous, field-free, nonrelativistic plasma is presented. The nonrelativistic assumptions are emphasized. (auth)

19891 STOCHASTIC SOLUTION OF THE BOLTZMANN EQUATION FOR THERMAL ELECTRONS IN AN ATTRACTIVE COULOMBIC POTENTIAL. Bell, M. J.; Kostin, M. D. (Princeton Univ., N. J.). J. Plasma Phys.; 3: 377-85(Sep 1969).

A stochastic method has been employed to investigate the distribution function of free electrons in gases in the field of a positive ion. Stochastic results have been obtained for several pressures and for both large (Langevin) and small ions, and the results have been compared with the solutions of the diffusion approximation and Pitaevskii's Fokker–Planck approximation to the Boltzmann equation. (auth) (UK)

19892 STRESS TENSOR FOR A RELATIVISTIC PLASMA IN A HIGH-FREQUENCY ELECTROMAGNETIC FIELD. Lupu, G. (Univ. of Cluj). Lett. Nuovo Cim.; 2: 839-40(21 Dec 1969).

Stress tensor calculations were made, taking collisional effects into account. (M.O.W.)

19893 THEORY OF A THICK DYNAMIC POSITIVE-ION SHEATH. Sander, K. F. (Cambridge Univ., Eng.). J. Plasma Phys.; 3: 353-70(Sep 1969).

The nature of the dynamic positive ion sheath formed in front of the negatively going anode of a gas discharge valve is considered. Approximations valid for thick sheaths at the high voltages appropriate to mercury valves are discussed, and a transient analysis of an idealized model performed. Expressions relating anode–cathode voltage and current to sheath thickness are derived. Approximate forms of these expressions are obtained, and numerical comparison is presented in one situation. (auth) (UK)

19894 ON THE STRUCTURE OF THE BOUNDARY LAYER SEPARATING A NEUTRAL ANISOTROPIC PLASMA FROM A MAGNETIC FIELD. Cohen, Leonard G. (Brown Univ., Providence); Cohen, Ira M. J. Plasma Phys.; 3: 311-30(Sep 1969).

The structure of the boundary layer separating a collisionless plasma from a one-dimensional magnetic field was studied for anisotropic particle velocity distribution functions. Charge neutrality was preserved throughout the boundary layer and self-consistent solutions were obtained for particles having two or three degrees of freedom and moving against either a plane or circular boundary. The results were compared with those for the structure of a boundary layer consistent with a cold streaming plasma. (auth) (UK)

19895 ASYMPTOTIC STABILITY OF MONOTONIC ELECTROSTATIC COLLISIONLESS SHOCK WAVES. Biskamp, D. (European Space Research Organization, Frascati, Italy). J. Plasma Phys.; 3: 411-16(Sep 1969).

The conditions imposed by Poisson's equation in the case of a monotonic shock wave are outlined. From these some properties of the electron distribution function are derivable. It is then shown that a certain class of distributions are stable with respect to electron oscillations. (auth) (UK)

19896 KINETIC DESCRIPTION OF HIGH-SPEED PROCESSES IN THE PLASMA. Polovin, R. V.; Rozhkov, V. V. (Physical Technical Inst., Kharkov). Dokl. Akad. Nauk SSSR; 189: 292-3(11 Nov 1969). (In Russian).

The state of a plasma is usually described by a distribution function consisting of the probability density of arbitrary coordinates and the velocity of the particle. The Fokker–Planck type kinetic equation is known to apply only to random Markov processes, for which the rate of change of the distribution function at the time t depends only on the value of f at that time and is independent of the previous history. An approximate exponential expression is given for a plasma containing particles with a mass m and a charge e. In order to indicate the characteristics of such a random process, the simplest case—that of a one dimensional, homogeneous, motion, is considered. A series of one-particle distribution function, depending on the velocity and its derivatives, was obtained; it is similar to N. N. Bogolyubov's multiparticle distribution function. It can be shown that in a plasma at rest the velocity of particles represents a Markov process if terms which are small in comparison with Coulomb logarithim, are neglected. (TTT)

19897 ON THE STRUCTURE OF COLLISIONLESS MAGNETOPLASMA SHOCK WAVES AT SUPER-CRITICAL ALFVEN–MACH NUMBERS. Woods, L. C. (Univ. of Texas, Austin). J. Plasma Phys.; 3: 435-47(Sep 1969).

Ions reflected from the sharp potential rise in a magnetoplasma, perpendicular shock wave result in a broad, small-amplitude "foot" in the magnetic field profile. A theory is given for the structure of this foot, which shows its shape to be a rather flat parabolic curve commencing at about half a Larmor radius in front of the shock proper. The theory also predicts the amplitude of the foot just in front of the sharp rise as a function of Alfvén–Mach number. Close agreement with experiment is found. (auth) (UK)

19898 STATISTICAL MECHANICS OF A WEAKLY TURBULENT STABLE PLASMA. Asseo, E. (Institut d'Astrophysique, Paris); Berthomieu, G.; Heyvaerts, J.; Mangeney, A. J. Plasma Phys.; 3: 499-524(Sep 1969).

The statistical mechanics of the weakly turbulent plasma is treated in an original manner by introducing the waves by means of the van Kampen modes. A system of coupled equations is de-

rived which relates the correlations between waves and waves, waves and particles, particles and particles. The quasi-linear theory is obtained at the first order, and the coupling wave equation at second order, under suitable assumptions. (auth) (UK)

19899 WEAK TURBULENCE SPECTRUM AND SECOND SOUND IN A PLASMA. Kaner, E. A.; Yakovenko, V. M. (Inst. of Radio Physics and Electronics, Kharkov). Zh. Eksp. Teor. Fiz.; 58: 587-96(Feb 1970). (In Russian).

Langmuir turbulence spectra and the possibility of propagation of low-frequency oscillations of the second-sound type in a turbulent plasma are considered. If collisions between plasmons and ions are not taken into account there should be two stationary nonequilibrium distributions which correspond to stationary fluxes of kinetic energy and number of plasma waves. Two branches of second sound should correspondingly exist. An exact power law solution of the form k^{-7} is found for that region in phase space, in which along with the four-plasmon interaction, nonlinear scattering of plasmons by ions is also important. It is proven that this distribution is stable with respect to low-frequency disturbances. The stability is of a diffusion nature. (auth)

19900 QUASIGASODYNAMIC DESCRIPTION OF A CLOUD OF HOT ELECTRONS IN A COLD PLASMA. Ryutov, D. D.; Sagdeev, R. Z. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 58: 739-46(Feb 1970). (In Russian).

The one-dimensional problem of expansion of a rarefied hot electron cloud through a cold plasma is investigated. It is shown that expansion is accompanied by excitation of Langmuir oscillations. The counter action of the latter on the hot electron distribution can be taken into account in the quasi-linear approximation. "Quasi-gasodynamic" equations describing the expansion process are derived by a method similar to the Chapman–Enskog method. Analytic solutions of the equations are obtained for various initial conditions. (auth)

Production

19901 METHOD FOR CONTAINING HIGH-ENERGY IONS. Dodo, Taro (to Hitachi Ltd.). Japanese Patent 1969-19319, 21 Aug 1969. Filed 23 Feb 1965.

The method proposed is for containing ionized atoms dissociated from the ionized molecules by injecting the high-energy beam of ionized molecules into a magnetic field. The advantage is the small loss of particles at a high temperature; a high-temperature plasma generator may easily be obtained. Ionized molecules are introduced into a magnetic field where the magnetic-force lines have been focused to the axis at the back and front ends. Then, high-frequency excitation which is equivalent to that of cyclotron resonance, is applied to the ionized molecules in order to dissociate the ionized molecules into ionized atoms; thus, the ionized atoms are contained in the magnetic field. (NSA of Japan)

19902 UNCERTAINTIES OF CALCULATED CHARACTERISTICS OF A TRANSPIRATION-COOLED ARC. Marschall, Ekkehard (Univ. of Minnesota, Minneapolis). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 7: 2142-4(Nov 1969).

Data are given relating the thermal conductivity and volumetric radiation of atmospheric argon in a transpiration-cooled arc to various temperatures. (M.O.W.)

19903 A NEW DEVICE FOR CREATING A STRONGLY FOCUSED HOT PLASMA JET: ROD PLASMA INJECTOR (RPI). Gryzinski, Michal (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 4: 680-706(Aug 1969).

A device is designed for creating a highly focused stream of hot plasma. The essential point of the concept lies in the replacement of solid electrodes of the coaxial plasma gun by grid electrodes (electrodes "transparent" to the particles) so that the radial motion of particles becomes unlimited, and a strong concentration of particles at the axis of the device can be achieved. Using a one-particle model, basic relations for perfectly transparent and perfectly smooth electrodes were derived. The question of space charges is briefly discussed. It has also been shown that the proper construction of "transparent" electrodes (rod plasma injector—RPI) and the properly chosen working conditions make possible to avoid a decrease in the focusing properties resulting from the rough structure of concrete electrodes. Numerical calculations for the particular construction were performed. Results are given of observations of plasma luminosity in the RPI performed with the application of a SFR-2M ultra-speed camera. The pictures obtained confirm theoretical forecasts made on the basis of the one-particle model. It was further proved that at pressures of the order of 10^{-4} mm of Hg, plasma is accelerated in the magnetohydrodynamic process, and at pressures of 10^{-2}–10^{-3} mm of Hg, a strong jet of plasma in the vicinity of the axis of the injector is formed. Some observations in the presence of an axial magnetic field of the order of 5 kG were also performed. (auth)

19904 INVESTIGATION OF A LASER MICROPLASMA IN THE FOCUS OF TWO LASER BEAMS. Dolgov-Savel'ev, G. G.; Karnyushin, V. N.; Sekerin, V. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Zh. Eksp. Teor. Fiz.; 58: 535-40(Feb 1970). (In Russian).

Results are presented of an experimental investigation of the properties of a plasma produced by focusing two opposite laser beams onto small crystalline lithium hydride targets. It is found that plasma formation proceeds in a more symmetric manner than in the case of a single laser beam. The velocity of separation of the external plasma layer is measured ($v \approx 4 \times 10^7$ cm/sec) as well as the velocity of the glowing boundary of the central zone ($v' \approx 2 \times 10^6$ cm/sec). (auth)

Stability

Refer also to abstract 19928.

19905 (INR-P-1132) TWO STREAM INSTABILITY AND ITS CLASSIFICATION INTO ABSOLUTE AND CONVECTIVE FOR HOT PLASMAS. Infeld, E.; Skorupski, A. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 21p. Dep. CFSTI (U. S. Sales Only).

Classification of the two-stream instability for hot plasmas is discussed. The method is based on the criterion of Fainberg, Kurilko, and Shapiro. The basis of the analysis is the "resonance" distribution, but a modified resonance distribution, leading to better results, is also investigated. The stability limit, classification into absolute and convective instabilities, as well as asymptotic growth rates, are given for some chosen values of stream densities and temperatures, and arbitrary stream velocities. A method for finding the maximum temporal growth rates is also outlined. (auth)

19906 (IPP-6/77) LINEAR AND TOROIDAL MAGNETOHYDROSTATIC EQUILIBRIA. Nuehrenberg, Juergen (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1969. 60p. (In German). Dep. CFSTI (U. S. Sales Only).

A class of linear and toroidal equilibria is investigated which is characterized as follows: β is of order one; the current density is determined so as to satisfy the secondary condition that the longitudinal current through each magnetic surface vanish; the only expansion parameter used in the approximate solution of the equilibrium problem is the quantity $\rho_{max}/R_o = \epsilon$, where ρ_{max} is the largest radius of the discharge tube and R_o the radius of curvature of the magnetic axis, which is constant in lowest order; moreover, the periodicity length L and the torsion in lowest order Λ/T_o of the magnetic axis obey the relations $2\pi\rho_{max}/L \sim \Lambda$, $\rho_{max}/T_o \sim \Lambda$ (i.e., $T_o/R_o \sim \epsilon$). Under these conditions the equilibria are of the $l = 1$ stellarator type, configurations of the $l = 2, 3, \ldots$ types not being included. (auth)

19907 (ORNL-TM-2864) THEORY OF HIGH-FREQUENCY INSTABILITIES IN MIRROR-CONFINED PLASMAS. Guest, Gareth (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 47p. (CONF-690828-1). Dep. CFSTI.
From 8th Faculty-Student Conference, Argonne, Ill.

The velocity-space instabilities of importance to mirror-confined fusion plasmas are reviewed briefly with an emphasis on the fundamental processes by which non-Maxwellian plasma constituents can transfer excess energy to plasma waves. The general dispersion relation and its electrostatic limit are discussed together with various aspects of wave-particle energy transfer. The basic notions are illustrated by application to flute-like modes, resonant and non-resonant loss-cone modes, drift-cone modes, negative-mass instabilities, and instabilities arising in finite-length plasma models. (auth)

19908 CURRENT INSTABILITIES OF WEAKLY IONIZED PLASMA. Ganefel'd, R. V. (Inst. of Electrodynamics, Kiev). Teplofiz. Vys. Temp.; 8: 205-7(1970). (In Russian).

The influence of Joule's dissipation on waves in plasma with a current was studied in the case in which the external magnetic field was absent and development of instabilities was limited. The experiments were carried out with a model simulating homogeneous stationary unperturbed plasma with a finite conductivity. Data obtained showed that under the conditions studied, Joule dissipation was the basic factor of wave amplification. (R.V.J.)

19909 DYNAMIC STABILIZATION OF THE INTERCHANGE INSTABILITY OF A LIQUID-GAS INTERFACE. Wolf, G. H. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Phys. Rev. Lett.; 24: 444-6(2 Mar 1970).

The Rayleigh–Taylor instability of a viscous liquid superimposed upon air can be dynamically stabilized by oscillating the liquid perpendicularly to its horizontal equilibrium surface, thus maintaining the position of the liquid for an arbitrary time. The viscosity of the liquid was found to have a strong influence on the stability of the short-wavelength modes. In the parameter regime investigated the effect of the compressibility of the gas was negligible. (auth)

19910 DISPERSION IN INHOMOGENEOUS PLASMA STREAMS. Burt, P. B. (Clemson Univ., S. C. Oak Ridge National Lab., Tenn.). J. Plasma Phys.; 3: 417-23(Sep 1969).

The instabilities in a two-stream plasma in which the density across the stream is variable are studied from the point of view of a scattering problem. Approximate dispersion relations are developed, one of which is identical with the infinite, homogeneous case. A second relation is obtained which depends upon the scale of density variation. (auth) (UK)

Thermonuclear Processes

19911 (AD–687874) IMPURITY EFFECTS IN INTENSE PLASMA RADIATION SOURCES. Dazey, Mitchell H.; van Paassen, Hugo L. L.; Josephson, Vernal (Aerospace Corp., El Segundo, Calif.). Nov 1968. Contract F04701-68-C-0200. 17p. (TOR-200(4308)-1; SAMSO-TR-69-132). CFSTI.

The effect on the neutron yield of variations in electrode material in a paraboloidal deuterium plasma focus assembly was investigated. Beryllium, titanium, iron, copper, and palladium anode tips were tested. The most significant improvement in neutron yields was produced by elements that are good deuterium absorbers, such as titanium. Average neutron yields were increased by a factor of 20 when the copper anode tip was replaced by a titanium tip. (USGRDR)

19912 (IPP–1/101) REACTION RATES AND ENERGY SPECTRA FOR NUCLEAR REACTIONS IN HIGH ENERGY PLASMAS. Lehner, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Sep 1969. 31p. Dep. CFSTI (U. S. Sales Only).

Total reaction rates and energy spectra of the generated particles are discussed for fusion reactions in high-energy plasmas. Examples, discussed in some detail, concern elliptic and monoenergetic velocity distributions of the plasma. One obtains energy spectra with very typical shapes that should be useful for diagnostic purposes. This is true, in particular, of reactions between different particles such as the d–t reaction. (auth)

19913 (IPP–1/103) NEUTRON FLUX ANISOTROPY OF HIGH ENERGY DEUTERIUM PLASMAS. Lehner, G.; Pohl, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany Oct 1969. 13p. Dep. CFSTI (U. S. Sales Only).

The neutron flux anisotropy of high-energy anisotropic deuterium plasmas is discussed for elliptic and monoenergetic velocity distributions of the deuterons. Because the anisotropy coefficient of the differential cross section is not very well known at low bombarding energies, computations were performed for two different laws corresponding to earlier results. (auth)

19914 CURRENT RATIOS IN COAXIAL PLASMA ACCELERATORS. Henry, R. P. (Univ. of Ottawa); Scott, D. S. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 7: 2153-5(Nov 1969).

Data are given on Hall-to-electrode current ratios for typical accelerators. The effects of various phenomena on accelerator performance are discussed. (M.O.W.)

19915 STUDY OF THE TRACK-TYPE PLASMA ACCELERATOR. Davydov, B. B.; Kostyukevich, E. A. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 3, 108-13(1968). (In Russian).

Racetrack-type plasma accelerators have been used for the study of the mechanism involved in the acceleration of plasma clusters at low pressures of 10^{-2} to 10^{-5} mm of Hg. This method was extended to investigations carried out at atmospheric pressure. The electron track consisted of 60 × 6 × 2 mm copper sheets placed at 10 mm from each other, using both parallel and divergent electrodes. The discharge current was measured by means of the Rogowski-coil method. It was found that the initial velocity of 3 to 5×10^3 m/sec of the layers was affected only slightly by the pressure. Qualitative analysis of the emission spectra revealed that the plasma consists of a gas-discharge plasma and was created also by erosion processes; the presence of Cu, Ca, and C atoms and of molecular bonds was also noted. The temperature ranged from 31,000 to 50,000°K, while the concentration of charged particles was $\sim 10^{17}$ cm^{-3}. (TTT)

19916 THERMONUCLEAR REACTOR WITH A PLASMA COLUMN HOVERING IN A HIGH FREQUENCY FIELD. Kapitsa, P. L. (Physics Lab., Moscow). Zh. Eksp. Teor. Fiz.; 58: 377-86(Feb 1970). (In Russian).

The possibility of using in a controlled thermonuclear reactor a deuterium plasma freely suspended in a high-frequency discharge is considered. Calculation methods are developed. The size of a reactor in which neutron emission is sufficient to replenish the energy expended in maintaining the discharge is determined. A design of a thermonuclear reactor is presented. The scientific problems that require further study in connection with development of this type of reactor are enumerated. (auth)

19917 INTERSTELLAR EXPLORATION MISSION PROFILES. Morgenthaler, George W. (Martin Marietta Corp., Denver). Ann. N. Y. Acad. Sci.; 163: 559-80(4 Sep 1969).

Various nuclear propulsion systems that might be used for interstellar exploration are considered. In the nuclear pulse engine concept, a large number of small nuclear explosive devices (~ 0.01 kt each) would be stored within the vehicle. They would be surrounded by inert neutron-absorbing debris, ejected to the rear at a rate of one per sec, and detonated. The momentum of the debris plasma would act against an ablating pusher plate at the rear of the vehicle. This transmits acceleration to the vehicle through a shock absorber system. Such vehicles might be as large as 10,000 to 30,000 tons. In the fission rocket concept, using solid-core nuclear reactors, a light-molecular-weight working fluid, such as hydrogen, is heated to high temperature and is expelled to give specific impulses of 800 to 1000 sec. With prevailing mass ratios, this is not nearly enough for interstellar flight. It was concluded that fission rocket propulsion will not provide the velocities and accelerations needed for desirable missions out to several light years. In the fusion rocket propulsion scheme, the two fusion elements are injected into a magnetic bottle (~10^5 G). They are confined long enough at temperatures of the order of 10^8K for large burnup fractions to be realized. The bottle is then opened at one end, allowing the plasma to escape and to produce thrust. Photon rockets (matter–antimatter rocket) are also examined. (BBB)

Wave Phenomena

19918 (IPP–1/104) RADIAL OSCILLATIONS OF PINCHED PLASMA COLUMNS. Lehner, G. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Nov 1969. 14p. Dep. CFSTI (U. S. Sales Only).

A discussion is presented of the radial oscillations of pinched plasma columns (z pinches, θ pinches and antipinches). Both the basic mode and its higher harmonics are included. In stability theory, these radial oscillations would be described as m = 0, k = 0 modes. They are, however, not described by the usual pinch dispersion formula in its limit $k \to 0$. They need a separate treatment, therefore. (auth)

19919 COLLISIONLESS DAMPING OF UNSTABLE WAVES IN A MIRROR-CONFINED PLASMA. Damm, C. C. (Univ. of California, Livermore); Foote, J. H.; Futch, A. H. Jr.; Hunt, A. L.; Moses, K.; Post, R. F.; Taylor, J. B. Phys. Rev. Lett.; 24: 495-9(9 Mar 1970).

Measurements of density thresholds for an ion-cyclotron instability in a mirror-confined plasma are interpreted in terms of a boundary for Landau damping of the unstable waves. Allowing for an observed normal-mode structure, experimental threshold values are accounted for quantitatively. (auth)

19920 WAVE REFLECTION FROM INHOMOGENEOUS ABSORPTION LAYER. Goncharenko, A. M. (Inst. of Physics, Minsk). Dokl. Akad. Nauk BSSR; 13: 893-5(Oct 1969). (In Russian).

An attempt was made of finding coefficients of electromagnetic wave reflection from inhomogeneous absorption layers. Formulas obtained for the reflection and penetration coefficients indicated that absorption inhibits wave interference in the layer. (R.V.J.)

19921 DISSIPATIVE SPECTRAL TRANSFER IN TURBULENT PULSATING PLASMA. Makhan'kov, V. G.; Tsytovich, V. N. Zh. Prikl. Mekh. Tekn. Fiz.; No. 6, 23-9(Nov-Dec 1969). (In Russian).

Excitation of low-frequency ($\omega^2 \ll \nu_e m_e/m_i$) acoustic oscillations by a transverse (hf) wave beam was studied. It is shown that, within the maximum conditions, the dispersion (and not only the increment of excitation) of low-frequency acoustic oscillations was found to be one-dimensionally connected to the energy density of hf waves. (tr-auth)

19922 A GUIDING-CENTRE VLASOV EQUATION AND ITS APPLICATION TO ALFVEN WAVES. Fejer, Jules A.; Kan,

Joseph R. (Univ. of California, San Diego). J. Plasma Phys.; 3: 331-51(Sep 1969).

Guiding-center approximations are used to derive the dielectric tensor of a collisionless plasma. This approximate dielectric tensor is used to obtain the dispersion relation of Alfvén waves in a warm plasma. In a "low-β" equilibrium plasma, Alfvén waves are shown to suffer considerable Landau damping if the propagation vector is almost perpendicular to the magnetic field. In a non-equilibrium plasma Alfvén waves can be generated by "negative Landau damping" even if β is low. For sufficiently high β the well-known "garden hose" instability can occur and is then probably dominant. The importance of these two instabilities in the magnetosphere and in the solar wind is discussed. (auth) (UK)

19923 THEORETICAL MODELS FOR RESONANCE OSCILLATIONS OF INHOMOGENEOUS PLASMAS. Dorman, G. (Polytechnic Inst. of Brooklyn). J. Plasma Phys.; 3: 387-410(Sep 1969).

The resonance oscillations of low-temperature, bounded, non-magnetized inhomogeneous plasmas are studied using different methods of solving the linearized Vlasov–Maxwell equations. A low-temperature expansion method of solving the orbit-integral solution of the Vlasov equation is compared to fluid descriptions of the plasma using the truncated moment equations. Numerical results for a one-dimensional plasma slab show qualitative agreement but some quantitative discrepancies. (auth) (UK)

19924 OBSERVATION OF IONIC SOUND IN A TOROIDAL PLASMA UNDER CONDITIONS OF TURBULENT HEATING. Perepelkin, N. F.; Fanchenko, S. D. Dokl. Akad. Nauk SSSR; 189: 288-91(11 Nov 1969). (In Russian).

During experiments on turbulent heating, experimental plasma oscillations have been observed at the electron-plasma frequency of ω_{pe}; there were indications that intensive oscillations are generated at the ion-plasma frequency range of ω_{pi}. In order to further study the problems, experiments were carried out to observe plasma noises at the $\omega \leq \omega_{pi}$ region, using the previously described "Virkh-2" device. Electric and magnetic probes were used for the measurements on the bases of the combined scattering of multimeter-range waves and analysis of the modulation by low-frequency oscillations of the plasma emission in the ω_{pe} range. The most important experimental result was the direct observation of plasma oscillation near the ion-plasma frequency which could be clearly correlated with the anomalous sensitivity of the plasma. Not only the electrostatic but also the magnetic probe recorded the ion-sound oscillations. (TTT)

19925 GENERATION OF HIGHER-HARMONIC ELECTRON CYCLOTRON FREQUENCIES IN PLASMA WITH BEAMS. Livshits, M. A. Zh. Prikl. Mekh. Tekn. Fiz.; No. 6, 40-51(Nov-Dec 1969). (In Russian).

Nonlinear excitation of higher-harmonic electron cyclotron frequencies in waves propagating perpendicularly to the external homogeneous magnetic field was studied in a Maxwellian plasma during penetration of a low-density electron beam. It was found that the excitation mechanism results in possible generation of cyclotron harmonics for plasma parameters in which, from the point of view of linear theory, such generation could not take place. Nonlinear increase of cyclotron harmonic generation during nonlinear scattering of longitudinal high-frequency waves, excited in plasma by the electron beam, was calculated. (R.V.J.)

19926 AMPLITUDE OF PLASMA WAVE ECHOES. Guillemot, Michel; Leprince, Philippe; Mathieussent, Gilles; Olivain, Jack; Perceval, Francoise (EURATOM-CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. B; 270: 317-19(2 Feb 1970). (In French).

In a collisionless plasma, if two electron plasma waves highly damped are excited at two different points, echoes will spontaneously appear. It is shown experimentally that the two waves initially excited play a dissymmetric part in the echo behavior, as is predicted by the theory. (France)

19927 NONLINEAR ANALYSIS OF PLANE ELECTROMAGNETIC WAVE PROPAGATION IN A SLIGHTLY IONIZED INFINITE PLASMA. Jancel, Raymond (Univ., Paris). Compt. Rend., Ser. B; 270: 313-16(2 Feb 1970). (In French).

Nonlinear effects related to plane electromagnetic wave propagation in a slightly ionized medium were studied by using expansion into low parameters expressing the nonlinearity of the plasma. (France)

19928 THE EFFECT OF WEAK COLLISIONS ON ION–ACOUSTIC WAVE INSTABILITIES IN A CURRENT-CARRYING PLASMA. Ong, R. S. B.; Yu, M. Y. (Univ. of Michigan, Ann Arbor). J. Plasma Phys.; 3: 425-33(Sep 1969).

The effect of weak collisions on ion–acoustic wave instabilities in a plasma with large ratios of electron to ion temperatures is investigated. The critical current for instability is shown to be significantly reduced by collisions. At the critical current the instability first occurs at nonzero values of $k\lambda_e$. As $k\lambda_e$ increases the collisional effects become less and less significant. (auth) (UK)

19929 HIGHER-ORDER RESONANCES IN A PLASMA. Lewak, G. J.; Chen, C. S. (Univ. of California, San Diego, La Jolla). J. Plasma Phys.; 3: 481-97(Sep 1969).

Resonances of a plasma driven into a weakly nonlinear régime are investigated by two different models. (1) A cold plasma driven by an extended wave source is considered. It is found that resonances can occur at fractions as well as multiples of the normal mode resonances. For the fractional resonances the response amplitude grows linearly with time, whereas for the harmonic resonances it grows exponentially with time. (2) An unmagnetized Vlasov plasma is excited by a two-grid source below the plasma frequency. A resonance is shown to occur when the driving frequency approaches one-half the plasma frequency. It is argued that such nonlinear resonances may be responsible for the Alouette II observations of resonances at fractions of the plasma frequency. (auth) (UK)

19930 POSSIBILITY OF THREE-WAVE COUPLING. Pointu, A. M.; Pomeau, Y.; Constantin, A. (Laboratoire de Physique des Plasmas, Orsay, France). J. Plasma Phys.; 3: 473-9(Sep 1969).

In the course of an experimental investigation of the Manley Rowe oscillations, some of the conditions required for an ideal coupling between three travelling waves were defined. It is shown that, because of homogeneity conditions, the only possible pumping wave is the electron cyclotron wave. Experimental values are given to within an order of magnitude for finite geometry. (auth) (UK)

19931 ON THE MODIFICATION OF THE BERNSTEIN MODES BY ELECTRON–ELECTRON COLLISIONS. Watson, S. R.; Harding, R. D. (Cambridge Univ., Eng.). J. Plasma Phys.; 3: 465-71(Sep 1969).

The dispersion relation for the Bernstein modes is derived, in the presence of a Fokker–Planck type collision term. Numerical solutions are obtained, and the results give an approximate formula for the collisional damping. The possibility of observing this damping experimentally is discussed. (auth) (UK)

19932 EVOLUTION OF THE WAVE SPECTRUM IN A PLASMA DUE TO STIMULATED SCATTERING. Kingsep, A. S.; Rudakov, L. I. Zh. Eksp. Teor. Fiz.; 58: 582-6(Feb 1970). (In Russian).

It is shown that nonlinear transfer of sufficiently narrow wave packets to the long-wave spectral region as a result of scattering by particles does not occur via diffusion "creeping" but via the satellite system. For Langmuir oscillations the process may represent either a discontinuous variation of wavelength or nonlinear reflection involving a change of the wave vector direction. Conditions are found for which evolution of broad wave packets ultimately leads to the same type of two-level transfer. (auth)

Shielding

Refer also to abstracts 18901, 19277, 19483, 20096, and 20177.

19933 (WAPD-TM-809) SPAN-4: A POINT-KERNEL COMPUTER PROGRAM FOR SHIELDING. Wallace, O. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Dec 1969. Contract AT(11-1)-Gen-14. 308p. Dep. CFSTI.

SPAN-4 is a shield-evaluation program which may be used to calculate fast-neutron dose rate, thermal-neutron flux, and gamma-ray flux, dose rate, and energy-absorption rate in rectangular, cylindrical, and spherical geometries by integration of appropriate exponential kernels over a source distribution. In SPAN-4, which is a substantial extension of SPAN-3, provision is made for increased flexibility in defining the shield configuration. A basic geometry (rectangular, cylindrical, or spherical) is defined for the shield configuration, and is used to specify the meshlines in the first-level shield unit. The first-level shield usually encompasses all of the shields and components which are to be represented in the problem. After the first-level shield unit has been specified, new shield units may be defined (using a different geometry than the first-level shield if desired), and portions of these new shield units may be embedded between the meshlines of the first-level shield unit. These new shield units become second-level shields. The embedding process is telescopic, such that third-level shield units may be defined and embedded in the

second-level shield units, and each new level of shield geometry is embedded in the next lower level. The meshlines which are specified in each shield may have variable spacing. Each cell formed by the meshlines of each shield unit may then be specified to contain either a composition (that is a void, element, compound, or mixture) or a cell-shaped portion of a higher-order shield unit. The highest-order shield unit(s) in a problem will therefore have a composition in every cell. Nine source and detector regions may be defined in a SPAN-4 problem, and again the geometries may be rectangular, cylindrical, or spherical. Sources and detectors may be located arbitrarily with respect to any shield unit, and the regions of integration (or detectors) over which the flux, dose rate, or energy-absorption rate are calculated may be parts of rectangular solids, parts of cylinders, or parts of spheres. The energy output or particle emission of each source is described by a general three-dimensional distribution function. The generality of the function requires that the integral be estimated by means of Gauss or Lobatto quadratures. Cross-section data, buildup factors, standard compositions, energy structures, dose conversion factors, an infinite-line source kernel, and Gauss quadratures are contained in a library. Data are given for most common shielding materials. SPAN-4 is written in FORTRAN IV, uses variable field lengths and dynamic storage allocation to handle large blocks of data, and is designed to run on a CDC-6600 computer with disc units and at least 64K of central memory. The program is intended to be used with the SCOPE operating system as implemented at Bettis. (auth)

19934 A STUDY OF THE RELATIONSHIP BETWEEN THE NEUTRON-ABSORBED DOSES IN AN UNDERGROUND STRUCTURE AND IN A SEMI-INFINITE MEDIUM. Roussin, Robert Warren. Urbana, Ill.; Univ. of Illinois (1969). 335p.

Thesis.

The shielding effectiveness of concrete underground cylindrical structures, embedded in a semi-infinite medium, against neutrons is studied by calculating the absorbed dose ratio. This is defined as the ratio of the neutron absorbed dose at a detection point inside a structure with roof thickness z, to the neutron absorbed dose at depth z in a semi-infinite medium. The neutron absorbed dose considered here is that due only to neutrons with energies greater than 1 keV. Modified versions of the ϕ5R and ACTIFK neutron Monte Carlo codes were written and used to perform the necessary calculations. Fast neutrons (E > 0.2 MeV), having an angular and energy distribution representative of fission neutrons which had traversed 1150 meters of air from a point source directly overhead, were used as a source of neutrons for the first part of the calculation. This was a calculation to determine the angular and energy distribution of neutrons penetrating concrete slabs of various thicknesses. The resulting distribution for a slab of thickness z was used as input to the second and third parts of the calculation. These involved the calculation of the neutron absorbed dose at detection points inside a cylindrical cavity (radius, r_c; height, H; roof thickness, z), and of the neutron absorbed dose at depth z in a semi-infinite medium. In the former calculation, neutrons were introduced at the plane of the cavity ceiling. In the latter, they were introduced at depth z in a semi-infinite medium. The directions and energies of the neutrons which were introduced were exactly the same in both of the calculations. The absorbed dose ratio was then obtained by taking the ratio of the results of the two calculations. (TSS) (DISS. ABSTR. INT., B)

19935 CALCULATION OF PERTURBATION OF THE INTENSITY OF γ RADIATION BY SMALL CAVITIES USING THE MONTE-CARLO METHOD. Kol'chuzhkin, A. M.; Uchaikin, V. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 130-2(1968). (In Russian).

The Monte-Carlo method is well suited for calculating the γ-radiation field behind a cavity barrier, using the perturbation theory. Such a calculation was carried out by determining the change in the intensity of the γ radiation resulting from the presence of the cavity, using the authors' previously published Monte-Carlo scheme. The integral which describes the perturbation at the boundary was used to check the results of the calculation. The radial distribution thus obtained served to construct a representation of the actual defect which consisted of a small cavity. The results indicated that the direct radiation was mainly perturbed; the scattered radiation was only slightly affected by small cavities. (TTT)

19936 ELECTRON ENERGY DEPOSITION IN MULTI-LAYERED SLABS AND CYLINDERS. Kniedler, Marcel John. College Park, Md.; Univ. of Maryland (1968). 395p.

Thesis.

Calculations were performed to determine the energy deposited, reflected, transmitted, and converted to bremsstrahlung by electrons impinging on slabs and cylinders. Information was developed for homogeneous and two-layered targets. A Monte Carlo technique was employed that simulates the electrons as they interact with their surroundings. The technique takes into account various aspects of penetration and energy transport: angular deflections, energy losses, and spatial displacements. The continuous slowing-down approximation given by Bethe's theory of stopping power was used. The multiple scattering angular deflections were determined according to the Goudsmit–Saunderson distribution using the Mott single scattering cross section. A parametric study was made using slabs of water and tungsten. The purpose was to illustrate the effect of slab thickness, electron energy, materials of different atomic number, and entrance angle of the electron to the slab on the energy reflected, deposited, transmitted, and converted to bremsstrahlung. Other parametric studies were made using slabs of iron/water, water/iron, and water/water. The thicknesses of the materials making up each slab were varied. An empirical set of equations is presented which summarizes the data for iron-water slabs. (TSS) (Diss. Abstr. Int., B)

19937 THE POSSIBILITY OF STUDYING "SKYSHINE" PHENOMENA OF GAMMA RADIATION ON LABORATORY SCALE. Bottino, A.; Cardinale, A.; Dell'Anna, G. (CNEN, Rome). Health Phys.; 17: 773-9(Dec 1969).

Experimental work on "skyshine" phenomena has been, until now, carried out in particular geometric configurations. A large plane surface without buildings or natural scatterers is needed, in order to eliminate the effects of perturbation. It was, therefore, interesting to investigate the possibility of carrying out such studies on a laboratory scale. The possibility of a model in which air is replaced by water in the interface geometry with regard to a ^{60}Co source shielded by a ring barrier which allowed no direct radiation to pass was examined. A calculation program was set up and a scale factor connecting doses in air and in water at the same number of mean free paths was found. (auth) (UK)

19938 CALCULATION OF THE PERTURBATION OF THE γ RADIATION INTENSITY BY SMALL DEFECTS. Kol'chuzhkin, A. M.; Uchaikin, V. V. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 129-30(1968). (In Russian).

Changes in the intensity of γ radiation, caused by a plane homogeneous barrier of a cylindrical cavity were investigated. These changes are at their maximum in a point lying on the axis of the cylinder. The unperturbed differential γ flux may be assumed to consist of the sum of unscattered and scattered fluxes. In order to estimate the actual values, the intensity of a monoenergetic, single-directional point source placed at the same location was examined, decomposing it also into the same two components. The formula derived by these calculations allows the estimation of the radiation intensity changes at the center of a defect. Under certain conditions, the formula obtained coincides with the well-known expression used in radiative flaw detection. The calculations revealed that as the energy of primary quanta increases, the contribution of the scattered radiation toward the creation of the defect decreases. (TTT)

19939 TRANSPARENT RADIATION-SHIELDING PLATE. ..chikawa, Wataru (to Asahi Glass Co.). Japanese Patent 1969-20000. 27 Aug 1969. Filed 26 Sep 1961.

The plate has the advantages of versatility in shape, size, and thickness, possibility of desired mechanical strength, and is suitable for various purposes such as in industry and medical therapy. A polymer or copolymer of ester acrylate, or a copolymer of ester acrylate and ester methacrylate, containing at least one iodide of potassium, sodium, calcium, barium or zinc, and mercuric iodide, is in a plate-shaped box of transparent glass. (NSA of Japan)

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Refer also to abstracts 19400 and 19719.

19940 POSSIBLE MECHANISM OF PHOTOTHERMAL AND THERMAL DESTRUCTION OF F CENTERS IN ALKALI-HALIDE CRYSTAL PHOSPHORS. Zaitov, F. N.; Dudarev, E. S.; Sidlyarenko, V. I. (Osh State Pedagogical Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.); 11: 1905-6(Feb 1970).

Translated from Fiz. Tverd. Tela; 11: 2362-4(Aug 1969).

A thermal bleaching-ionic conductivity study was made of the possible connection between thermal destruction of F centers and ionic processes in NaCl doped with Ca, Ag, and Pb, and KCl doped with Sr. From the activation energies, the temperatures of the two stages in the thermal destruction of F centers coincide with those of the stages of the ionic conductivity. The activation energies of the two thermal bleaching stages are 0.35 and 0.85 eV, corresponding to the activation energies of motion of the dipolons V^+V^-

and cation vacancies, respectively. A plot of the temperatures of maximum destruction rates vs ionic conductivity shows that the stability of the F centers in the first stage does not depend on the conductivity, while the second stage does. A possible sequence of reactions in the destruction of the ions and F centers is given. (D.L.C.)

19941 HOLE PROCESSES AND STRUCTURE-SENSITIVE RADIATION COLORING OF KCl. Muradov, S. M. (Inst. of Physics and Astronomy, Tartu). Sov. Phys.-Solid State (Engl. Transl.); 11: 1927-8(Feb 1970).

Translated from Fiz. Tverd. Tela; 11: 2386-8(Aug 1969).

The temperature dependences of q (efficiency of radiation coloring) and hole mobility are compared for KCl crystals alone and doped with divalent impurity (Tl, Ca, Ag or Pb). The growth curves of the F centers during x irradiation were studied. It was found that the fastest saturating step was absent in the doped crystals, indicating that this step is caused by OH^- impurity. The second saturating step N_F^{II} increases sharply near 210°K, where processes requiring migration of V_K centers occur. It is suggested that this increase in N_F^{II} is caused by hole migration. The case of Ca-doped KCl is discussed in some detail. (D.L.C.)

19942 MEASUREMENT OF LIFE TIMES OF MINORITY CARRIERS AND KINETICS OF THE STIMULATED RADIATION OF CdS AND ZnTe IN EXCITATION WITH A BEAM OF FAST ELECTRONS. Vlasov, A. N.; Kurbatov, L. N.; Petrova, I. Yu.; Soroko-Novitskii, N. V.; Sharin, A. I. Ukr. Fiz. Zh.; 14: 1845-51(Nov 1969). (In Russian).

The times of cathode luminescence-decay for CdS and ZnTe semiconductors were measured. Two times of decay were found for CdS at 300°K: $\tau_1 = 9$ nsec and $\tau_2 = 3.7$ nsec, and at 85°K only one time $\tau = 1.1$ nsec. For ZnTe at 85°K $\tau = 0.55$ nsec. The change in the spectrum of stimulated radiation of these semiconductors in time was also investigated. (auth)

19943 X-RAY INFLUENCE ON THE GYULAI EFFECT IN KBr SINGLE CRYSTALS. Zaganescu, M.; Birau, O.; Andru, D. (Univ. of Timisoara, Rumania). Rev. Roum. Phys.; 14: 559-61(1969).

The effects of x rays on the Gyulai effect (increase of electric conductivity by plastic deformation) were studied for KBr single crystals. The x irradiation was found to further increase the conductivity of deformed KBr, whereas the effect in undeformed KBr is a decrease. A dynamic model for explaining this effect is suggested, in which the interstitial Br ion formed by x rays is collected at the dislocation. (D.L.C.)

19944 SEMICONDUCTOR SILICON. First International Symposium on Silicon Materials Science and Technology Held May 5-9, 1969, New York. Haberecht, Rolf R.; Kern, Edward L. (eds.). New York; Electrochemical Society, Inc. (1969). 776p. (CONF-690506).

Fifty-five reviews and papers are arranged under the following headings: chemical preparation, bulk single crystal growth, epitaxial crystal growth, heteroepitaxy, diffusion and doping, analysis of trace impurities, defects and their influence on device properties, and electrical characterization. Separate abstracts were prepared for three papers dealing with Cd and Te implantations, ion implantation damage, and neutron activation analysis and autoradiography. (D.L.C.)

For abstracts of individual papers see: 19945, 19946, and 19977.

19945 ANALYSIS OF Cd AND Te IMPLANTATIONS IN SILICON BY CHANNELING AND HALL MEASUREMENTS. Picraux, S. T.; Johansson, N. G. E.; Mayer, J. W. (California Inst. of Tech., Pasadena). pp 422-32 of Semiconductor Silicon. /Haberecht, Rolf R. (ed.). New York; Electrochemical Society, Inc. (1969).

From 1st International Symposium on Silicon Materials Science and Technology, New York. See CONF-690506.

Analysis of n- and p-type silicon samples implanted with 20- to 50-keV Cd and Te ions at substrate temperatures of 350°C and room temperature (R.T.) were made by use of Hall and sheet resistivity measurements and channeling techniques. In R.T. implants, ~60% of the Te ions were on substitutional sites when the lattice reordered during anneal. Donor action is observed with the number of carriers/cm^2 ~$1/_{40}$ of the implanted dose. In R.T. Cd implants, less than 10% of the Cd remained in the samples after the lattice disorder was annealed, and no electrical activity was observed. In 350°C implants, 20 to 30% of the Cd ions were on regular interstitial sites with a negligible substitutional component. During anneal there was no decrease in the total amount of Cd, and n-type behavior was found, with the number of carriers/cm^2 three orders of magnitude lower than the implanted dose. (auth)

19946 CRYSTAL DAMAGE IN ION-IMPLANTED SILICON. Irving, Stephen M. (Signetics Corp., Sunnyvale, Calif.). pp 433-44 of Semiconductor Silicon. /Haberecht, Rolf R. (ed.). New York; Electrochemical Society, Inc. (1969).

From 1st International Symposium on Silicon Materials Science and Technology, New York. See CONF-690506.

Crystal damage due to ion implantation is shown to be dependent on the relationship between substrate temperature and dose rate. Individual damage sites coalesce to form continuous subsurface amorphous layers which may spread to the surface of the wafer. Post-implantation heat treatments have not succeeded in recovering the crystal damage when a surface amorphous layer is present. At lower dosages, where no surface amorphous layer is present, recovery is obtained between 700°C and 800°C. (auth)

19947 RELATION OF RATE OF INTRODUCTION OF RADIATION DEFECTS TO CONCENTRATION OF PHOSPHORUS IN SILICON SPECIMENS IRRADIATED BY REACTOR NEUTRONS. Vavilov, V. S.; Uvarov, E. F.; Chukichev, M. V. (Moscow State Univ.). Fiz. Tekh. Poluprov.; 3: 1838-43(Dec 1969). (In Russian).

The irradiation of n-type crystals of silicon by neutrons in a heavy-water reactor resulted in the appearance of silicon A and E centers, which are a function of P concentration. The introduction of A-centers depended very little on the concentration of phosphorus, and the efficiency of the introduction of E centers depended greatly on the concentration of donors according to the law of exponents. A centers were the predominating type of defects in silicon with the greatest content of oxygen 5 to 7×10^{17} cm^{-3}, and this was true for P concentration up to 1×10^{16} cm^{-3}, while in silicon with 2×10^{16} cm^{-3} oxygen content, defects prevailed only up to the concentration of $P = 1 \times 10^{15}$ cm^{-3}. The probability of atomic capture by P in 50 to 70 times exceeded the probability of capture by oxygen atoms. It was found that the spin disintegration factors for levels A and E centers were equal to 2. Results conformed with previous electron irradiation data of silicon. The temperature of irradiation can also influence the efficiency of the introduction of A and E centers. (tr-auth)

19948 IRRADIATION AND ANNEALING OF CRYSTALS OF GERMANIUM WITH HIGH DENSITY DISLOCATIONS. Smirnov, L. S.; Stas, V. F.; Khaiuovskaya, V. V. (Inst. of Physics of Semiconductors, Novosibirsk, USSR). Fiz. Tekh. Poluprov.; 3: 1760-5(Dec 1969). (In Russian).

Measurements were made on the temperature dependence of the concentration and the mobilities of the charge carriers after irradiation by electrons and on the different stages of annealing in crystals of Ge without dislocations, with growth dislocations of 10^3 cm^{-2}, and by dislocations introduced by bending plastic deformation. The magnitude of microhardness was measured and it was established that in crystals containing high density dislocations, lesser concentration of centers with $E_v + 0.10$ eV levels were observed. (tr-auth)

19949 ANNEALING KINETICS OF RECOIL ATOMS IN SOLIDS. Veljkovic, S. R. (Univ., Belgrade). Phil. Mag.; 21: 627-32(Mar 1970).

The annealing kinetics of recoil atoms, which have undergone a (n, γ) reaction, has been described by an equation of the form: $\exp(-kt^n)$. This annealing law could be understood in the light of the localization of reactions in limited, separated, disordered zones surrounding recoil atoms, where the thermal diffusion of constituents should have a dominant role. (auth) (UK)

19950 SPUTTERED-ATOM EJECTION PATTERNS FROM (100) Ge SURFACES. MacDonald, R. J. (Australian National Univ., Canberra). Phil. Mag.; 21: 519-32(Mar 1970).

The sputtered-atom ejection patterns from (100) Ge bombarded with 5-, 10-, and 15-keV Ar^+ ions have been studied as a function of dose, dose rate, and target temperature. An abrupt transition from a disordered to an ordered surface structure is observed at 330 ± 5°C, and this temperature is energy-independent. Spot patterns showing preferential ejection along a ⟨111⟩ direction are obtained above the transition temperature. This has been interpreted as an assisted focusing sequence. The pattern further mirrors the symmetry of the (100) surface and the ejection process has been interpreted as a combination of focusing sequences and surface effects of the type suggested by Lehmann and Sigmund. (1966). (auth) (UK)

19951 DEUTERON AND HELIUM-ION CHANNELING IN URANIUM DIOXIDE. Eriksson, L. (Research Inst. for Physics, Stockholm); Davies, J. A. Ark. Fys.; 39: 439-50(Oct 1969).

The channeling behavior of 0.975-MeV deuterons was investigated in uranium–dioxide single crystals. Wide-angle scattering off the uranium atoms and the ^{16}O (d,p) ^{17}O reaction was used to

observe the angular dependence of the interaction of the deuteron beam with both the uranium and oxygen atoms independently. Along those directions where the oxygen and uranium atoms lie on separate atomic rows (or planes), the two processes exhibit completely different orientation dependencies; the critical angle for channeling by uranium rows, for example, is 2 to 3 times larger than that for the oxygen rows. On the other hand, along the (111) axis [or the (110) plane] where both atomic species lie on the same row or plane, the orientation dependencies of the two processes are identical. A few wide-angle scattering measurements were made also with MeV helium ions in order to obtain better depth resolution. The observed "zero-depth" values of the critical channeling angles are approximately 25% smaller than theoretical predictions, even when the influence of lattice vibrations is included. (auth) (Sweden)

19952 THERMOSTIMULATED CURRENTS AND THERMOELECTRIC POWER IRRADIATED MgO. Mallard, W. C.; Crawford, J. H. (Univ. of North Carolina, Chapel Hill). Solid State Commun.; 7: 1767-70(15 Dec 1969).

Thermostimulated Current (TSC) and Thermoelectric Power (TEP) techniques have been used to study the decay of V_1 centers produced in MgO crystals which were γ-irradiated at ~35°C. The TSC data yields an activation energy of 1.10 eV for the V_1 decay while the TEP results demonstrate that holes are the mobile charge carriers. These experiments also indicate retrapping plays a major role in the decay processes. (auth) (UK)

19953 DIVACANCY-ASSOCIATED HOLE CENTERS IN NEUTRON-IRRADIATED BaF_2. Kazumata, Yukio (Japan Atomic Energy Inst., Ibaraki). Solid State Commun.; 7: 1753-5(15 Dec 1969).

A new type of hole center which was assigned to an F_2^- molecular ion associated with two positive ion vacancies was observed in neutron-irradiated BaF_2. The spin Hamiltonian constants are $g_{||} = 2.0026 \pm 0.0005$, $g_\perp = 2.021 \pm 0.001$, $T_{||} = 921.5 \pm 1.0$, and $T_\perp = 35 \pm 10$. The centers decay at about 275°K. (auth) (UK)

19954 RADIATION EFFECTS IN TELLURIUM-DOPED GERMANIUM. Cleland, J. W.; Crawford, J. H. Jr. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 1: 713-17(15 Jan 1970).

Ambient-temperature irradiation of Te-doped n-type Ge by 1.7-MeV electrons, ^{60}Co photons, thermal neutrons, and fast neutrons decreased the carrier concentration, presumably by removing conduction electrons into deep-lying radiation-induced acceptor states. There was no evidence for the shallow acceptor state 0.2 eV below the conduction-band characteristic of irradiated Ge doped with As or Sb. Vacuum annealing at 450°C for 16–20 hr has been shown to restore the carrier concentration and mobility of As- or Sb-doped Ge to pre-irradiation values; however, comparable annealing reduced the apparent concentration of Te double donors after fast-neutron irradiation. The loss of Te double-donor action can be postulated as field-assisted migration of a composite Te-vacancy imperfection. The electric field in the space-charge zone surrounding a fast-neutron-induced disordered region is thought to be sufficiently large to sweep the Te–vacancy complexes (assumed to be positive) into the disordered region where they aggregate and become electrically inactive. (auth)

19955 CHANGES IN ELECTRONIC PROPERTIES OF CARBONS IRRADIATED BY NEUTRONS. Rappeneau, J. (CEA, Saclay, France); Micaud, G.; Pacault, A.; Marchand, A.; Amiell, J. Carbon; 8: 55-61(Feb 1970). (In French).

Two nuclear graphites, a well-oriented graphite PGCCL and a pyrocarbon deposited at 2100°C, were irradiated with neutrons at 35°C. The diamagnetic and paramagnetic susceptibilities, Hall effect, magnetoresistance, and electrical resistivity were measured at room temperature as a function of the irradiation dose. The studies show that the damage is less pronounced when the carbon is better ordered. (auth) (UK)

19956 ESR AND OPTICAL ABSORPTION STUDIES OF ION-IMPLANTED SILICON. Crowder, B. L.; Title, R. S.; Brodsky, M. H.; Pettit, G. D. (IBM Watson Research Center, Yorktown Heights, N. Y.). Appl. Phys. Lett.; 16: 205-8(1 Mar 1970).

The g value, line shape, and linewidth of an ESR signal in Si layers damaged by ion implantation of Si, P, or As at room temperature are found to be identical to those of the electron states observed in amorphous Si films prepared by rf sputtering. Interference phenomena observed in the optical absorption spectra allow a determination of the depth to which the Si was damaged by the energetic heavy ions. These two techniques together provide a new tool for investigating lattice disorder in ion-implanted Si layers. (auth)

19957 CHANNELING STUDY OF BORON-IMPLANTED SILICON. North, J. C.; Gibson, W. M. (Bell Telephone Labs., Murray Hill, N. J.). Appl. Phys. Lett.; 16: 126-9(1 Feb 1970).

The channeling technique has been used to determine the lattice location of boron implanted into silicon by using the $^{11}B(p,\alpha)$ nuclear reaction. Approximately 30% of the boron lies on substitutional sites after a room-temperature implantation of $3 \times 10^{15}/cm^2$. The substitutional content decreases with annealing temperature up to 700°C and then increases at higher annealing temperature. This explains a reverse annealing behavior observed in the carrier concentration. Nearly all of the boron lies on substitutional sites after annealing at 1100°C. The nonsubstitutional boron atoms do not occupy the normal tetrahedral interstitial sites. For annealing temperatures up to 500°C, they appear to lie along ⟨110⟩ atomic rows, but they do not lie midway between ⟨110⟩ row lattice sites. After higher-temperature annealing, their location appears less well-defined. (auth)

19958 ION IMPLANTATION DEPTH DISTRIBUTIONS: ENERGY DEPOSITION INTO ATOMIC PROCESSES AND ION LOCATIONS. Brice, David K. (Sandia Labs., Albuquerque, N. Mex.). Appl. Phys. Lett.; 16: 103-6(1 Feb 1970).

A useful method of calculating the energy/unit depth deposited in atomic processes by energetic ions in solids is presented. The calculated energy density is shown to correlate well with previous Monte Carlo calculations of the vacancy concentration resulting from ion bombardment and recent experimental measurements of the depth distribution of ion damage. The method also provides the depth distribution of ions in the solid as a function of their energy during the stopping process. This information would allow, for example, calculation of the location and rate of various energy-dependent interactions between incident ions and host atoms. (auth)

19959 DEPTH DISTRIBUTION OF DIVACANCIES IN 400-keV O^+ ION-IMPLANTED SILICON. Stein, H. J.; Vook, F. L.; Borders, J. A. (Sandia Labs., Albuquerque, N. Mex.). Appl. Phys. Lett.; 16: 106-8(1 Feb 1970).

The integral depth distribution for divacancies produced in silicon at room temperature by 400-keV O^+ ion implantation has been measured. The divacancy distribution was determined from repeated measurements of the characteristic 1.8μ absorption band following successive anodizations and strippings of the implanted layer. Most of the divacancies are located between 4500 and 12,000 Å with a half-value at ~7500 Å and a concentration of $\sim 4 \times 10^{19}$ cm^{-3} near the center of the distribution. The measured integral depth distribution for the ion-produced divacancies is proportional within experimental error to theoretical calculations by Brice for the integral depth distribution of ion energy spent in atomic processes. (auth)

19960 DEPTH DISTRIBUTION OF EPR CENTERS IN 400-keV O^+ ION-IMPLANTED SILICON. Brower, K. L.; Vook, F. L.; Borders, J. A. (Sandia Labs., Albuquerque, N. Mex.). Appl. Phys. Lett.; 16: 108-10(1 Feb 1970).

The depth distribution of Si-P3 centers in 400-keV O^+ ion-implanted silicon was determined using EPR measurements in conjunction with anodization and stripping of the implanted layer. The depth distribution of the EPR centers compares favorably to theoretical calculations by Brice for the depth distribution of the energy deposited into atomic processes and with infrared absorption measurements of the depth distribution of divacancies by Stein, Vook, and Borders. The combined EPR and infrared measurements indicate that the Fermi level in the damaged layer lies between $E_c - 0.21$ eV and $E_v + 0.25$ eV. (auth)

19961 DELAYED NEUTRONS FROM NEUTRON-IRRADIATED LiF CONTAINING COLOR CENTERS. Fowler, W. Beall; Martin, T. P. (Lehigh Univ., Bethlehem, Pa.). Phys. Rev. Lett.; 24: 557-9(16 Mar 1970).

It is shown that the neutron–electron interaction is orders of magnitude too small to allow neutrons to be bound to electron-excess color centers in alkali-halide crystals, as was indicated experimentally by Grant and Cobble, Phys. Rev. Lett., 23: 741 (1969). (auth)

19962 DETERMINATION OF CHANNELING PROBABILITY FROM TRANSMITTED-PARTICLE ENERGY SPECTRA. Altman, M. R. (Rutgers–The State Univ., New Brunswick, N. J.); Feldman, L. C.; Gibson, W. M. Phys. Rev. Lett.; 24: 464-7(2 Mar 1970).

The channeling probability for 5.0-MeV protons in the {110} planes of silicon has been deduced from the transmitted-particle energy distribution. The fraction of the incident beam initially channeled is found to be substantially larger than that calculated from the usual interpretation of scattering measurements in channeling and nonchanneling directions. This discrepancy is ascribed to nonchanneled particles with trajectories which yield high probabilities for particle scattering but which have a small effect on the energy loss of the transmitted particles. (auth)

19963 ISOLATING SURFACE LAYERS ON METALLIC CONDUCTORS PRODUCED BY ION BOMBARDMENT. Balarin, M.; Otto, G.; Storbeck, I.; Schenk, M.; Wagner, H. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Thin Solid Films; 4: 255-63(Oct 1969).

Isolating surface layers were formed on different metals and on silicon by means of bombardment with ionized oxygen and air, respectively. The production of these layers is described, and the electrical properties are reported. Furthermore the advantages of this procedure are discussed, and possibilities for the application of this effect are shown, particularly for the production of microelectronic devices. (auth)

19964 COLORATION OF CaF_2 BY LOW-ENERGY ELECTRONS. Rao, D. R.; Bose, H. N. (Indian Inst. of Tech., Kharagpur, India). J. Phys. Soc. Jap.; 28: 152-7(Jan 1970).

Calcium fluoride crystals, which exhibit a weak four-band spectrum (Smakula bands) on coloration by x rays, are found to be colored by low-energy electrons (~10 kV) in the temperature range of 150 to 400°C, and show only two bands. A spectrum exhibiting the α and β bands of Mollwo can be produced even at 28°C if the crystals are x-irradiated prior to electron bombardment. The results are explained by the fact that low-energy electrons, because of their short range, can affect a negligibly small number of impurity ions; the effects of trace impurities can, thus, be avoided by this method of coloration. It is further concluded that diffusion of neutral fluorine atoms takes place during the electron bombardment and thereby facilitates the formation of F centers. The experiments on the bleaching of x-irradiated crystals under electron bombardment also provide supporting evidence for the diffusion of trapped holes (F^0 atoms). (auth)

19965 THERMOLUMINESCENCE OF γ-IRRADIATED POLYTETRAFLUOROETHYLENE. Tomita, Akihiro (Osaka Univ.). J. Phys. Soc. Jap.; 28: 731-8(Mar 1970).

Measurements of the thermoluminescence glow curves of polytetrafluoroethylene and polychlorotrifluoroethylene irradiated in air and in vacuum are made in the temperature range -196 to 150°C. Seven glow peaks appear at the following temperatures: 126, 104, 38, 22, -8, -67, and -96°C. The glow peaks which appeared at -67°C in the case of irradiation in vacuum and at -96°C in the case of irradiation in air are the principal ones. The spectra and the decays of these glow peaks are measured. The effects of the crystallinity of the sample on the glow are examined. The results are interpreted on the basis of electron-trapping theory, and some deductions are given of the luminescence centers and the electron traps. (auth)

19966 THE MAGNETIC ANISOTROPY OF IRON-NICKEL (50-50) THIN FILM INDUCED BY NEUTRON AND α-PARTICLE IRRADIATION. Tamagawa, Nobuaki (Sony Corporation Research Lab., Yokohama, Japan); Harasawa, Susumu. J. Phys. Soc. Jap.; 28: 564-9(Mar 1970).

Measurements of the magnetic anisotropy induced by irradiation of reactor neutrons or 1.47-MeV α particles at 563°K in a magnetic field of about 2000 Oe were made on evaporated Fe-Ni (50%-50%) thin films with single and polycrystalline structures. The observed induced uniaxial anisotropy was a few times larger than that of the bulk alloys. The temperature dependence of this anisotropy was measured at temperatures from 77°K to 663°K and fits quite well with the third power of the magnetization. Above 573°K, the magnetic anisotropy decreases with increasing temperature and time of heat treatment. The temperature dependence is well described by assuming the activation energies of 0.55 eV between 573°K and 773°K and 2 eV above 773°K. (auth)

19967 ABSORPTION SPECTRA OF STRONGLY ALLOYED N-GaAs IRRADIATED BY PROTONS. Krivov, M. A.; Red'ko, V. P.; Ramazanov, P. E.; Mamontov, A. P.; Budnitskii, D. L. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 143-4(1969). (In Russian).

Absorption spectra of n-GaAs specimens with an electron concentration of 1.5×10^{19} cm^{-3}, a Hall mobility of $\mu \simeq 3000$ cm^2/v · sec, and 90 to 100 μm thickness were measured before and after exposure to irradiation with a 5-MeV proton flux of 2×10^{15}/cm^2. Following irradiation, it was observed that absorption by free carriers diminished considerably; however, the character of the absorption remained unchanged. Data obtained indicated that ~30 free electrons disappeared with each incoming incident proton. (R.V.J.)

19968 EFFICIENCY OF F-CENTER ACCUMULATION IN KI AS A FUNCTION OF THE INTENSITY OF PROTON BEAMS. Alekseev, P. D. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 134-6(1969). (In Russian).

Kinetics of F-center storage in KI crystals irradiated by 3.2-MeV proton beams at temperatures of 295, 150, and 90°K were studied for F-center concentrations of 3×10^{16} to 3×10^{18} cm^{-3}. The curves of kinetic storage of F centers in KI crystals showed that, at room temperature and low intensity of irradiation, the curves have a two-stage character (similar to that of x, γ, and uv irradiation). With increased radiation intensity, the first stage vanished and the second stage, for which the deflection from linearity in the F-center concentration is over 1.5×10^{18} cm^{-3}, became strongly pronounced. Diagrams reveal the qualitative dependence of the efficiency of color accumulation centers on the proton beam intensity and on temperature. (R.V.J.)

19969 OPTICAL STUDIES OF IONIC CRYSTALS BY PULSED X- AND ULTRAVIOLET RADIATIONS. Ueda, Masayasu; Hirai, Masamitsu (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No 1, 63-6(1968). (In Japanese).

The purpose of this study was to clarify the formation mechanism of color centers in the crystal which were produced during the irradiation by a pulsed monoenergetic electron beam (about 10 nsec half-width, 60-MeV bremsstrahlung, 1A). The crystal was exposed to light from a 500-W xenon lamp, and a portion of transmitted rays was taken out through a spectrometer and its intensity observed with a synchroscope. When this crystal was irradiated with pulsed electron beam for a short time, the transmission factor of the crystal decreased because of the formation of F centers. Accordingly, the coloring rate could be analyzed by photographic observation. Using a KCl crystal as a sample, the results of a preliminary test for the experimental devices are briefly reported. (NSA of Japan)

19970 PHOTOMETRIC STUDY OF IONIC CRYSTAL WITH PULSED ELECTRON BEAMS. II. Ueda, Masayasu; Hirai, Masamitsu (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 114-18(Dec 1968). (In Japanese).

In an alkali-metal halide crystal irradiated by an electron beam, colored centers such as F or V centers are formed. In this experiment, the formation state of the F center from room temperature to liquid nitrogen temperature and the luminescence caused by the electron beam radiation were measured. The beam generated by the radiation of single electron pulse from a linac on a crystal entered into a monochromator through a filter and was accepted by a photomultiplier, while its signal was transmitted by coaxial cable to the third measuring chamber and measured with an oscilloscope. KCl was used as the testing sample for both absorbance and luminescence. When the crystal was new, the F center reached its maximum concentration within 50 nsec of the width of electron beam used. About half of the formed F centers disappeared with a time constant of about 50 nsec. This extinction seemed to be caused by the rebonding with an H center (Cl_2^-) existing in the vicinity. A certain part increased by the constant of 0.6 μsec, the life of the excited state of F center. This part was greatly affected by the radiation frequency. When the measuring temperature changed, the constant became shorter. Its state generally agreed with the temperature coefficient of the life of the beam generated when electrons dropped from the excited state to the ground state of the F center and also with the temperature coefficient of the life of luminescence. These facts could not be observed by the usual method, but they were measured only with the short electron beam pulse such as 50 nsec. (NSA of Japan)

19971 PHOTOMETRIC STUDY OF IONIC CRYSTAL WITH PULSED ELECTRON BEAMS. III. Ueda, Masayasu; Hirai, Masamitsu (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 108-19(Jun 1969). (In Japanese).

The formation and decay of F and V centers in KCl crystals were studied with a pulsed electron beam. The observation at liquid nitrogen temperature has been reported previously, and this report concerned measurements at liquid helium temperature. F centers were generated within 80 ± 15 nsec, and a half of the generated F centers recombined with H centers within 40 μsec after the irradiation, thereby disappearing. As the temperature of the crystals rose higher above liquid helium temperature, the time constants of both formation and decay became smaller. It is suggested that, in the mechanism of F-center formation, a Cl^- ion is excited by the ionizing radiation, and a neutral Cl atom escapes from the lattice site, leaving an anion vacancy with an electron, and both F and H centers are generated in a pair. (NSA of Japan)

19972 SECONDARY DEFECTS PRODUCED IN GERMANIUM BY FISSION-FRAGMENT IRRADIATION AND SUCCESSIVE ANNEALING. Izui, Kazuhiko; Otsu, Hitoshi (Japan Atomic Energy Res. Inst., Tokai, Japan). J. Electron. Microsc. (Tokyo); 18: 257-65(Dec 1969).

Electron microscopic observations were carried out on the secondary defects produced in germanium by fission-fragment irradiation and successive annealing. Small spots observed in

as-irradiated specimens are considered to be displacement spike regions produced by primary knockons with energies larger than several 10 keV. These defects are found to grow by the annealing at above 300°C at the expense of smaller defects. From analysis of fringe patterns appearing on these grown defect regions, it is found that these large defect regions are vacancy-rich zones and the lattices are contracted by about 3% within these regions. (NSA of Japan)

19973 LUMINESCENT AND ACCUMULATION PROPERTIES OF CaF_2:Nd DURING X IRRADIATION. Kolomoitsev, F. I.; Ivanii, G. M. (Dnepropetrosk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 147-9(1969). (In Russian).

Luminescence and accumulation properties of CaF_2:Nd phosphors during x irradiation were studied at various temperatures. Tabulated data show that at arbitrary intensities and times of irradiation at room temperature, the total area of released light sum was larger than the area of accumulated light sum which may be explained by a faster radioinduced development of luminosity and recombination of free charges with localized ones during the external damping taking place during irradiation. (R.V.J.)

19974 RADIATION DAMAGE IN GYPSUM. Patel, A. R.; Raju, K. S. (Sardar Patel Univ., Vallabh Vidyanagar, India). J. Phys. Chem. Solids; 31: 331-5(Feb 1970).

Gypsum single crystals were irradiated with different doses of neutrons and their hardness determined by a Vicker's microhardness indentor. It was observed that the hardness of the irradiated crystal decreased with increase in the total dose of irradiation and the variation of hardness within the irradiated crystal was similar to that of the crystal heated to the dehydration temperature and then allowed to cool. From Laue x-ray diffraction studies of irradiated crystals, distortion of the lattice was observed and it was shown that similar distortion in the lattice was produced when the crystals were heated to the dehydration temperature and cooled. Infrared absorption studies of the irradiated, heated and the unirradiated crystals were made. Less extended peaks relating to lattice water and peaks relating to free sulphate groups in the irradiated and heated crystals were identified. The implications are discussed. (auth) (UK)

19975 RADIATION-INDUCED MOVEMENT OF CHARGE-COMPENSATING IONS IN CaF_2. Twidell, J. W. (Univ. of Essex, Colchester, Eng.). J. Phys. Chem. Solids; 31: 299-305(Feb 1970).

Trivalent rare earth ions were incorporated substitutionally in CaF_2 where charge compensation occurred (a) by F^- interstitials and O^{2-} substitutional ions forming complexes with the trivalent ions, or (b) by processes remote from the trivalent ions. The ESR spectra of the magnetic rare earth ions indicate the presence or absence of n.n. compensating ions, and can monitor the movement of these ions from or into n.n. sites. Ion movement was stimulated by uv irradiation and electron bombardment, and changes in the valence state of the rare earth ions occurred. Thermal annealing techniques give an activation energy for F^- interstitial movement of 1.0 ± 0.1 eV. The self-diffusion of oxygen in the CaF_2 lattice was monitored in a new way. (auth)(UK)

Physical Properties

Refer also to abstracts 19430, 19453, and 19938.

19976 MAGNETOCRYSTALLINE ANISOTROPY OF TERBIUM, DYSPROSIUM, AND HOLMIUM. Feron, Jacques-Louis (CNRS, Grenoble, France). Compt. Rend., Ser. B; 269: 611-14(6 Oct 1969). (In French).

Starting from the magnetization curves, the anisotropy coefficients of terbium, dysprosium, and holmium are discussed; their thermal variations are compared with the predictions of the one-ion model. (tr-auth)

19977 NEUTRON ACTIVATION ANALYSIS AND AUTORADIOGRAPHY OF SILICON. Martin, Joachim A. (Siemens Aktiengesellschaft, Erlangen, Ger.). pp 547-57 of Semiconductor Silicon. /Haberecht, Rolf R. (ed.). New York; Electrochemical Society, Inc. (1969).

From 1st International Symposium on Silicon Materials Science and Technology, New York. See CONF-690506.

After a few remarks on the techniques of activation analysis and autoradiography as applied to ultrapure silicon, results are given from actual investigations. Only the copper content shows any direct relationship with the carrier lifetime in zone-refined silicon. Finally, reference is made to the contamination of the silicon slices in different stages of the manufacture of semiconductor components. (auth)

19978 OPTICAL ABSORPTION IN THE MIXED CRYSTAL SYSTEMS ZIRCONIUM DIOXIDE–HAFNIUM DIOXIDE AND NIOBIUM PENTOXIDE–TANTALUM PENTOXIDE, Bendoraitis, Joseph George. Philadelphia; Temple Univ. (1968). 137p. Thesis.

Studies have been conducted to determine the effect of mixed crystal formation on the optical energy gap of oxides exhibiting closed-shell electronic configurations and very similar cationic ratii. Homogeneous monoclinic ZrO_2-HfO_2 solid solutions were prepared by thermal decomposition of the mixed zirconium and hafnium mandelato complexes, while orthorhombic $Nb_2O_5-Ta_2O_5$ solid solutions were obtained by ignition of hydrous oxides from basic hydrolysis of mixed metal ethoxides. X-ray analysis did not reveal the presence of ordered phases in either system; however, the presence of small amounts of the $\alpha-Nb_2O_5$ phase was detected at compositions above 0.75 mole fraction Nb_2O_5. The lattice parameters varied linearly with composition in the ZrO_2-HfO_2 system, but varied nonlinearly in the $Nb_2O_5-Ta_2O_5$ system. Energy gaps of the powder specimens were determined by diffuse reflectance spectroscopy using two methods, which define the gap energy from (1) a linear extrapolation of the absorption edge to the minimum absorption level on the energy axis, and (2) the energy corresponding to the point of half maximum edge absorption. The strong optical absorption in the closed-shell oxides is assumed to arise from direct interband transitions between a filled p-type valence band of the oxygen ligands and a conduction band formed from the empty 4d and 5d orbitals overlap to form a common conduction band with possible inclusion of the overlying s-levels. In both the ZrO_2-HfO_2 and $Nb_2O_5-Ta_2O_5$ systems, the variation of the energy gap with composition of the mixed crystal exhibited a monotonic negative deviation from linearity. "Virtual crystal" analysis for a perfectly periodic binary mixed crystal predicts a linear variation with composition. Agreement with experimental results is obtained from perturbation theory, which predicts that the energy gap of a binary solid solution deviates from a linear interpolation as $Cf(1-f)$, where f is the fraction of one of the constituents, and C depends among other things, on both the variation of the potential from the average and on the amount of short-range order. (Diss. Abstr. Int., B)

19979 DETERMINATION OF THE MAGNETIC UNIAXIAL ANISOTROPY CONSTANTS OF HOLMIUM FROM MAGNETIZATION MEASUREMENTS IN FIELDS UP TO 240 kOe. Vishnyakov, Yu. S.; Ivannikov, V. L.; Levitin, R. Z.; Ponomarev, B. K. (Moscow State Univ.). Zh. Eksp. Teor. Fiz.; 57: 1956-61(Dec 1969). (In Russian).

The magnetization of a holmium single crystal in the basal plane and along the hexagonal axis is measured at temperatures between 80 and 300°K in pulsed magnetic fields up to 240 kOe. The uniaxial anisotropy constants of holmium are calculated from magnetization data by taking into account the paraprocess and interaction responsible for the helicoidal structure of the metal. Between 80 and 122.5°K, the temperature dependence of the first uniaxial anisotropy constant of holmium is satisfactorily described by the theoretical formula. The value of the first anisotropy constant at 0°K obtained by extrapolation from the temperature region above 80°K is $(2.5 \pm 0.25) \times 10^7$ erg/g. (auth)

19980 ELECTRIC TRANSPORT AND DIFFUSION OF MOLYBDENUM IN A NICKEL–MOLYBDENUM SOLID SOLUTION. Kalinovich, D. F.; Kovenskii, I. I.; Smolin, M. D.; Statsenko, V. M. (Inst. of Problems in Material Sciences, Kiev). Sov. Phys.-Solid State (Engl. Transl.); 11: 1919-20(Feb 1970).

Translated from Fiz. Tverd. Tela; 11: 2378-80(Aug 1969).

Diffusion coefficients and effective charges of Mo were measured at 950 to 1350°C in wires of Ni–16 at. % Mo alloy, using ^{99}Mo deposited in the center. The diffusion coefficients followed the equation $D = 1.30 \exp(-54{,}600/RT)\,cm^2/sec$. The effective electric charge Z^* varied from 20.4 at 950°C to 16.4 at 1350°C; it followed the equation $Z^* = 3.5 + 59{,}700\{1/[T + (\rho_0/\alpha)]\}$. The sign of the charge indicates that the Mo ions have an acceptor role. (D.L.C.)

19981 SPUTTERING PHENOMENA AND DEPTH DISTRIBUTION. IV. CATHODIC SPUTTERING OF Nb_2O_5, Ta_2O_5, AND WO_3. Nghi, L. Q.; Kelly, Roger (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 48: 137-45(15 Jan 1970). (In French).

Three different methods have been used to determine the sputtering yield (S) for 2- to 30-keV Kr ions on the amorphous anodic oxides Nb_2O_5, Ta_2O_5, and WO_3. The methods were based on (a) the change of interference colors due to ion bombardment, (b) the perforation of a film of free oxide by an intense ion beam, and (c) the loss of weight of the target. Although S for $Kr-WO_3$ was larger than expected, S for $Kr-Nb_2O_5$ and $Kr-Ta_2O_5$ was similar to what has been found for other oxides. For example, at 4 keV, S lies between 1.1 and 2.4 atoms/ion for Ar or Kr bombardment of Al_2O_3, Nb_2O_5, SiO_2, Ta_2O_5, TiO_2, and UO_2, whereas it is 6.2 atoms/ion for

WO_3. The results were interpreted first with a modified form of the theory of Rol et al., in which S is equated to $K'E/R_m$, where K' is a constant in Å/keV and R_m is the experimental median range. A good fit between experiment and theory was obtained for K' equal to 25 for Nb_2O_5, 13 for Ta_2O_5, and 51 for WO_3. The recently formulated theory of Sigmund, which is in principle completely analytical, was also considered. The observed values of S could be made compatible with the predictions of the theory by taking the following values for E_b, the surface binding energy (units of kcal/gram atom): 100–150 for Nb_2O_5, 200–250 for Ta_2O_5, and 45–60 for WO_3. These latter values are similar to the heats of atomization. (auth)

19982 ELECTRICAL PROPERTIES OF TANTALUM CARBIDE AT HIGH TEMPERATURES. Golikova, O. A.; Dzhafarov, E. O.; Avgustinik, A. I.; Klimashin, G. M. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 11: 1936-8(Feb 1970).

Translated from Fiz. Tverd. Tela; 11: 2395-7(Aug 1969).

The electric properties of TaC_x were investigated as a function of carbon content and temperature. Thermal emf and electric conductivity were measured at 20 to 2000°C. The dependence of current carrier concentration on the carbon content is discussed. The mobility is calculated, and it is found that the dominant phenomenon is scattering by lattice vibrations, not by carbon vacancies or excess metal. The nature of the conductivity is considered. (D.L.C.)

19983 ELECTRONIC STRUCTURE OF NIOBIUM AND TANTALUM. Mattheiss, L. F. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 1: 373-80(15 Jan 1970).

The band structures and Fermi surfaces of niobium and tantalum are calculated via the augmented-plane-wave (APW) method. Relativistic effects are included in the tantalum but not the niobium calculation. The resulting niobium and tantalum Fermi surfaces are similar to a Fermi-surface model for the vanadium-group transition metals that was proposed previously by the author. This model contains closed hole pockets centered at the symmetry points Γ and N of the bcc Brillouin zone plus a multiply connected hole sheet which extends from Γ to H along ⟨100⟩ directions. Areas and cyclotron masses of closed extremal orbits on the niobium and tantalum Fermi surfaces are calculated as a function of magnetic field direction in the {100} and {110} planes. The calculated areas are in quantitative agreement with recent experimental results. The maximum discrepancies are 18 and 10% for niobium and tantalum, respectively. The effect of niobium Fermi-surface anisotropy on the temperature dependence of the upper critical field is evaluated in terms of the Hohenberg–Werthamer theory. The results of this calculation overestimate the experimentally observed effect by a factor of about 2.5. (auth)

19984 EXPERIMENTAL STUDY OF THE FERMI SURFACES OF NIOBIUM AND TANTALUM. Halloran, M. H. (Univ. of Southern California, Los Angeles); Condon, J. H.; Graebner, J. E.; Kunzler, J. E.; Hsu, F. S. L. Phys. Rev., B; 1: 366-72(15 Jan 1970).

The Fermi surfaces of niobium and tantalum were investigated experimentally utilizing the techniques of the de Haas–van Alphen effect at magnetic fields up to 31 kOe and magnetothermal oscillations at magnetic fields up to 110 kOe. Oscillations associated with extremal orbits on two Fermi-surface sheets of each element were observed. The Fermi surface is found to have qualitatively the same topology in both metals: a set of six closed surfaces substantially distorted from ellipsoidal shape and centered at N in the bcc Brillouin zone; and a multiply connected jungle-gym surface consisting of interconnecting arms along ⟨100⟩ directions with intersections at Γ and H. The agreement between these data and recent augmented-plane-wave (APW) energy-band calculations is excellent. The minimum cross sections of the ⟨100⟩ arms of the jungle gym have areas of 0.138 $Å^{-2}$ in Nb and 0.263 $Å^{-2}$ in Ta; and the principal cross sections of the distorted ellipsoids are 0.636, 0.757, and 0.857 $Å^{-2}$ in Nb, and 0.434, 0.580, and 0.59 $Å^{-2}$ in Ta. A third surface of holes centered at Γ is predicted by band-structure calculations, but was not observed unambiguously in this work. Effective masses were measured at several orientations, and comparison with the APW calculations yield average mass-enhancement factors of 1.75 for Nb and 1.85 for Ta, in fair agreement with predictions based on phonon enhancement. (auth)

19985 SPECIFIC HEAT OF DILUTE ALLOYS OF TIN IN INDIUM BETWEEN 0.5 AND 1.7 K. White, H. W.; McCollum, D. C. (Univ. of California, Riverside). Phys. Rev., B; 1: 552-4 (15 Jan 1970).

Specific-heat measurements were made on dilute alloys of tin in indium in the temperature range 0.5 to 1.7°K. For tin concentrations of 0, 0.8, 2.1, 4.9, and 9.7 at. %, γ (electronic specific heat) values of 1.66, 1.66, 1.74, 1.88, and 1.92 mJ/mole K^2 were found. This represents a more rapid increase in γ than would be predicted on the assumption of rigid parabolic bands, and may be due to filling of third-zone α arms. The variation of γ with concentration is different from that of the Knight shift. (auth)

19986 EFFECT OF TEMPERATURE ON THE FERMI SURFACE OF BERYLLIUM. Tripp, J. H. (Univ. of Connecticut, Storrs). Phys. Rev., B; 1: 550-1(15 Jan 1970).

By straightforward extension of the pseudopotential model, which was originally developed for pure beryllium at 0°K, it is shown how to obtain the changes in the Fermi surface with temperature. Because of the very high Debye temperature of Be, the changes even at room temperature are not large. In particular, the calculations show that there are not changes in topology of the Fermi surface with rise in temperature and that the probability of breakdown between orbits in a magnetic field is not significantly enhanced. (auth)

19987 KOHN ANOMALIES IN TUNGSTEN AND OTHER Cr-GROUP METALS. Rice, T. M.; Halperin, B. I. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 1: 509-16(15 Jan 1970).

A detailed examination is made of the series of Kohn anomalies near the H point of the Brillouin zone of tungsten, arising from the "nesting" of the electron jack and hole octahedron. An analytic model of the Fermi surface, introduced by Girvan, Gold, and Phillips to fit their de Haas–van Alphen data, is employed. The electron susceptibility is evaluated and its maximum is found to occur at a sharp peak. The effect of the Kohn anomalies on the phonon spectrum and lifetime is estimated. Applications to other Cr-group metals are briefly considered. (auth)

19988 STRUCTURE AND MAGNETIC PROPERTIES OF TbSi. Nguyen Van Nhung; Laforest, J.; Sivardiere, J. (GEN-G, Grenoble, France). Solid State Commun.; 8: 23-30(Jan 1970). (In French).

The intermetallic compound TbSi, type FeB (space group Pnma), becomes antiferromagnetic below $T_N = 57°K$. The magnetic peaks observed by neutron diffraction can be indexed in a unit cell doubled along the b direction. The magnetic structure is colinear and can be explained by pseudo-dipolar exchange forces. (auth) (UK)

19989 ELECTRONIC PROPERTIES OF WELL-ORIENTED GRAPHITE. Cooper, J. D.; Woore, J.; Young, D. A. (Imperial Coll. of Science and Tech., London). Nature (London); 225: 721-2(21 Feb 1970).

It has become apparent that conventional interpretations of Hall and magnetoresistive effects in graphite are not consistent with one another nor with current ideas on the locations of electrons and holes within the Brillouin zone. The authors' measurements on irradiated pyrolytic single-crystal graphite support the reassignment of the positions of the electron and hole Fermi surfaces made by Schroeder et al. (Phys. Rev. Lett. 20: 1292 (1968)). Evidence was also obtained that apparent contradictions between the low-field Hall coefficient of pyrolytic and single-crystal graphites represent genuine extremes of behavior. Studies of the anisotropy of the pressure dependence of conduction suggested that electron–hole scattering of majority carriers is more important than carrier–phonon interactions in the basal planes, while the drag effect of majority on minority carriers is unimportant in explaining the low-field Hall effect. A potentially confusing situation has thus arisen. Some findings in this connection, arising from magneto-optical experiments and fast neutron irradiations, are discussed. From the former experiments it appears that the carriers comprise heavy majority electrons and holes, together with light minority holes, and the association of majority electrons and holes with short and long de Haas–van Alphen periods, respectively, was confirmed by observations of shifts in these periods induced by light pre-irradiation with fast neutrons. Pre-irradiation produces acceptors which become negatively charged, thus lowering the Fermi energy, and according to the conventional band model the de Haas–van Alphen periods should diverge with increasing neutron dose, whereas they converge, supporting the new locations of electrons and holes. The findings necessitate a complete reassessment of the field dependence of the Hall coefficient in terms of mean free paths, recrystallization, crystallite boundary scattering, heavy majority carriers, light minority electrons, drag effects, majority holes, electron–hole scattering, effective mass distribution, etc. (UK)

19990 A NEW PHENOMENON: NUCLEAR ANTIFERROMAGNETISM. Abragam, Anatole (College de France, Paris); Goldman, Maurice. Atomes (Paris); 24: 661-8(Nov 1969). (In French).

The Saclay experiment for demonstrating the existence of nuclear antiferromagnetism at low temperatures is described. A general introduction to nuclear spin and the magnetic properties

of nuclei is given. A simple cubic lattice of nuclear moments was chosen and adiabatic demagnetization in the turning reference effected. An antiferromagnetic state can arise for a negative temperature in the rotating reference when the initial polarization of the nuclear moments, following the solid effect, exceeds 30%, and the magnetic field is oriented along a quaternary axis of the crystal. The crystal used was fluorine, and the solid effect was produced by doping with U(III). A ^{3}He cryostat was employed to produce a temperature of 0.3°K, and from this point the nuclear spin temperature could be reduced to 10^{-6}°K. The frequency for producing the solid effect was 70 GHz and that for adiabatic demagnetization and nuclear measurement was 100 MHz. Plans for further studies, such as those at positive temperatures, are described. (BBB)

19991 EFFECT OF UNIAXIAL CONSTRAINTS ON MAGNETIC ORDER TEMPERATURES OF A DYSPROSIUM MONOCRYSTAL. Bartholin, Henri; Bloch, Daniel (CNRS, Grenoble, France). Compt. Rend., Ser. B; 269: 496-8(22 Sep 1969). (In French).

The variation of magnetic ordering temperatures of a dysprosium monocrystal under uniaxial constraints following the principal crystallographic axes was measured. (tr-auth)

19992 TRAPPING OF POSITRONS BY DISLOCATIONS IN ALUMINUM. Hautojaervi, P.; Tamminen, A.; Jauho, P. (Technical Univ., Helsinki). Phys. Rev. Lett.; 24: 459-61(2 Mar 1970).

Positron lifetime measurements have been performed in plastically deformed aluminum single crystals. Evidence of a second nonspurious lifetime component has been observed. The results are interpreted as the trapping of positrons by dislocations. The lifetimes are found to be 172 psec in the perfect crystal and 228 psec in a dislocation. The escape probability of trapped positrons is estimated to be zero. (auth)

19993 ELECTRON STATE IN BeO STUDIED BY COMPTON SCATTERING MEASUREMENT. Fukamachi, Tomoe; Hosoya, Sukeaki (Tokyo Univ.). J. Phys. Soc. Jap.; 28: 161-7(Jan 1970).

In order to investigate the electron state in BeO, the Compton profile was measured on a powder sample by use of Ag Kα radiation. On the other hand, theoretical profiles have been calculated from available four sets of electron wave functions, which mostly concern isolated atoms. Comparison of the observed profile with the theoretical ones showed that wave functions of Be^{2+} O^{2-} state are better than those of BeO and Be^{+} O^{-}. However, there still remains a small discrepancy, which may be due to complexity of chemical bond in solid state. A numerical table is given for the theoretical Compton profiles due to atoms, Be^{+}, Be^{2+}, O^{-} and O^{2-}. (auth)

19994 ELECTRICAL RESISTIVITY OF TUNGSTEN FILMS PREPARED BY WF_6 REDUCTION. Mayadas, A. F.; Cuomo, J. J.; Rosenberg, R. (International Business Machines Corp., Yorktown Heights, N. Y.). J. Electrochem. Soc.; 116: 1742-5 (Dec 1969).

Resistivity and thickness measurements were made at 296 and 4.2°K for W films deposited on substrates of oxidized Si, sputtered Al_2O_3, and sapphire. The polycrystalline films deposited on SiO_2 and sputtered Al_2O_3, exhibited high 296°K resistivities and low resistivity ratios (~2–4); this was shown to be due to grain-size effects. Epitaxial single-crystal films were grown above 500°C on sapphire, and their 4.2°K resistivity was strongly dependent on thickness. The Fuchs thickness-size effect is shown to be small at 296°K but appreciable at 4.2°K. It is concluded that the high resistivity is not due to impurities but to grain boundary scattering of electrons. (D.L.C.)

19995 ENERGY BANDS AND OPTICAL PROPERTIES OF HEXAGONAL BORON NITRIDE AND GRAPHITE. Doni, E.; Parravicini, G. Pastori (Univ., Pisa, Italy). Nuovo Cim.; 64B: 117-44(11 Nov 1969).

The band structure of hexagonal boron nitride in the two-dimensional approximation is computed using the tight-binding approximation in a semi-empirical way. The results are compared with those of the isoelectronic compound graphite and are shown to be in agreement with the basic experimental data. Three-dimensional band structure calculations were also performed and the effect of the different spatial structure of boron nitride and graphite lattices on the electronic levels at the saddle point is shown to produce a doublet in the optical excitation spectrum of BN. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 19229 and 19235.

19996 THERMAL CANCELLATION OF APPLIED MAGNETIC FIELDS FOR MOESSBAUER SOURCES. Clark, P. E. (Univ. of Exeter, Eng.). J. Phys., D (London); 3: 337-41(Mar 1970).

It is shown theoretically that it is possible to reduce the effect of an applied magnetic field on a Moessbauer source by suitable choice of the source temperature. Application of this method to a ^{57}Co-in-Pd source yields a value of J = 7.2 ± 0.8 for the spin associated with dilute Fe in Pd. (auth) (UK)

19997 NUCLEAR MAGNETIC RESONANCE IN THE 100-NANOSECOND STATE OF ^{57}Fe FOLLOWING SELECTIVE EXCITATION OF THE HYPERFINE SUBLEVELS. Heiman, Neil D. Baltimore; Johns Hopkins Univ. (1969). 139p. Thesis.

A technique is described for producing and detecting excited-state nuclear polarization by means of nuclear resonance radiation (Moessbauer effect). This is the first successful extension to nuclei of the concept of selective excitation of magnetic sublevels that was the basis of numerous experiments using atomic levels. The technique has been used to perform two experiments. In the first, the energy distribution of the resonantly scattered radiation was measured as a function of the Doppler shift of the incident gamma rays. In the second, nuclear magnetic resonance transitions in the 14.4-keV level of ^{57}Fe were directly observed for the first time. In the course of these experiments, it was discovered that additional distinct lines appeared in the Moessbauer absorption pattern of a metallic ^{57}Fe foil when it was subjected to a radio-frequency magnetic field. These additional lines have been interpreted as acoustically modulated sidebands arising from magnetostrictive effects within the iron. These sidebands provide a consistent explanation of anomalous "NMR" effects seen by other researchers. (Diss. Abstr. Int., B)

19998 THE THEORY OF TEMPERATURE RELATIONS AND ISOTOPIC EFFECTS IN THE KNIGHT SHIFT. Zhogolev, D. A. (Physical-Technical Inst. of Low Temperatures, Kharkov). Fiz. Metal. Metalloved.; 27: 769-79(May 1969). (In Russian).

At $T \neq 0$ an expression was obtained for addition to the Knight shift, dependent on the change in the electron energy spectrum by electron–phonon interaction. At $T \gg \omega_D$ it has a relative order of magnitude T/μ and leads to temperature changes in the Knight shift of the same order, which are usually considered as thermal expansion, and change with temperature at the expense of divergence of the atomic volume from equilibrium value in an oscillating lattice. The temperature relation of the isotopic effect on the Knight shift, dependent on phonon addition, was studied. The isotopic effect on Knight shift in superconductors is discussed. It is significantly stronger at the expense of great isotopic changes in the energy gap. (tr-auth)

19999 MOESSBAUER-EFFECT OBSERVATIONS OF RECOIL RADIATION DAMAGE FOLLOWING COULOMB EXCITATION IN VARIOUS Hf COMPOUNDS. Jacobs, C. G. Jr.; Hershkowitz, N. (Univ. of Iowa, Iowa City). Phys. Rev., B; 1: 839-50(15 Jan 1970).

Moessbauer-effect experiments following Coulomb excitation were performed involving Hf nuclei in Hf metal, HfB_2, HfC, HfN, and HfO_2. The first excited states of ^{178}Hf, ^{180}Hf, and ^{177}Hf were populated via Coulomb excitation by 6-MeV α particles. The majority of the experiments were performed with both targets and absorbers near liquid-nitrogen temperature. Anomalous hyperfine interactions are found in all of the compounds when they are used as targets, compared to the hyperfine interactions observed when they are used as absorbers. The anomalous interactions are interpreted in terms of lattice distortions resulting from vacancies produced in the locale of the decaying recoil Moessbauer nuclei following Coulomb excitation. The degree of lattice distortion is found to be dependent upon the bonding charteristics of the compounds. (auth)

20000 ^{115}In NMR IN THE INDIUM-RICH ALLOYS In–Cd, In–Hg, AND In–Tl AT 4.2°K. Thatcher, F. C.; Hewitt, R. R. (Univ. of California, Riverside). Phys. Rev., B; 1: 454-62(15 Jan 1970).

Nuclear magnetic resonance was observed in the indium-rich alloys In–Cd, In–Hg, and In–Tl at 4.2°K. Measurements were made of the isotropic Knight shift, anisotropic Knight shift, quadrupole-coupling frequency, and linewidths as a function of solute concentration to 4.7 at. % Cd, 4.3 at. % Hg, and 7.9 at. % Tl. The isotropic Knight shift exhibits a dip similar to that previously observed in In–Sn and In–Pb. The sign of the electric field gradient was deduced from the quadrupole-coupling frequencies in the alloys, and is negative. The screening theory of Kohn and Vosko is found to describe line broadening in these indium alloys, and the enhancement factor of that theory is determined to be 85 ± 15. (auth)

20001 MOESSBAUER EFFECT OF THE 93-keV TRANSITION IN ^{67}Zn. de Waard, H.; Perlow, G. J. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 24: 566-9(16 Mar 1970).

Moessbauer spectra obtained with carefully annealed sources consisting of ^{67}Ga in ^{66}ZnO and with ^{67}ZnO absorbers show a well-resolved hyperfine structure that can be attributed to equal quadrupole splittings in source and absorber, with coupling constants $e^2qQ = 2.47 \pm 0.03$ MHz. The resonant absorption for the strongest line of the spectrum ranges from about 0.15 to 0.55% and its linewidth from 2.7 to 5 times the natural width $2\Gamma_0$. A pressure of about 40 kbar applied to the source gives rise to about an 8% reduction in its quadrupole coupling constant. (auth)

20002 INCOHERENT NEUTRON SCATTERING AND NUCLEAR MAGNETIC RESONANCE. Summerfield, G. C. (Univ. of Michigan, Ann Arbor); Kleinberg, Robert. J. Phys. Soc. Jap.; 28: 644-6(Mar 1970).

A relationship between incoherent neutron scattering and nuclear magnetic resonance is pointed out. This relationship is then used to compare neutron scattering and NMR in water. (auth)

20003 TO THE THEORY OF LINE SATURATION IN NUCLEAR QUADRUPOLE RESONANCE. Buishvili, L. L.; Volgina, G. A. (Tbilisi State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 12: 1805-10(1969). (In Russian).

A quantum-statistical consideration of saturation in nuclear quadrupole resonance in the absence of an external magnetic field is given. It is shown that the changes of the temperature of a dipole–dipole tank in NQR give results similar to those observed for saturation of nuclear magnetic resonance. (auth)

20004 A NEW METHOD FOR DETERMINATION OF THE QUADRUPOLE MOMENT OF ^{57}Fe. Rosenberg, M. (Inst. of Physics, Bucharest); Mandache, S.; Niculescu-Majewska, H.; Filotti, G.; Gomolea, V. Phys. Lett.; 31A: 84-5(26 Jan 1970).

The quadrupole moment of ^{57}Fe was determined by measuring the quadrupole splittings of ^{27}Al (NMR) and ^{57}Fe (Moessbauer spectroscopy) in the octahedral sites of the same spinel lattice. (auth)

Theory

20005 THEORY OF HYPERFINE PROPERTIES OF BERYLLIUM AND MAGNESIUM METALS. Jena, P. (Univ. of California, Riverside); Das, T. P.; Mahanti, S. D. Phys. Rev., B; 1: 432-47 (15 Jan 1970).

A detailed analysis of the hyperfine properties of the lighter group-II metals, beryllium and magnesium, was carried out to understand the relation between the electronic structures of these hcp metals. The "lens" and "butterflies" of the magnesium Fermi surface have large s character, leading to an appreciable value of the Knight shift K_s. In contrast, beryllium does not have these pieces of the Fermi surface, and this qualitatively explains the vanishingly small K_s for beryllium. Core polarization (cp) plays an important role in explaining the experimental values of K_s. There is a basic difference between beryllium and magnesium as regards the cp contribution to the Knight shift (K_{cp}). For beryllium, $K_s^{cp,p}$, the p part of the cp contribution is negative and this, together with a small direct contribution K_s^d, leads to a vanishingly small value for K_s (0.7×10^{-3}%), as compared to -0.25×10^{-2}% obtained experimentally. Orbital effects are expected to explain the remaining discrepancy in beryllium. For magnesium, K_s^{cp} is roughly 38% of K_p^d, and the total theoretical value of K_s is 0.0554%, compared to the experimental value of 0.112%. The uncertainties in the exchange enhancement of χ_p and the role of other contributions to K_s are discussed. The relaxation time in beryllium is quite large because of the small spin density, and T_1T is found to be 1.0035×10^4 deg sec as compared to 1.66×10^4 obtained experimentally. No experimental value of T_1T is available for magnesium. The theoretical value, including exchange enhancement effects, is 0.0346×10^4 deg sec. The relatively large p contribution to K_s^{cp} in both the metals plays an important role in the deviation of $K_s^2T_1T$ from its ideal value, $(\gamma_e/\gamma_N)^2\hbar/4\pi k_B$. (auth)

Theoretical Physics

Refer also to abstracts 20197 and 20220.

20006 THE ELECTROMAGNETIC SHIFT OF LANDAU LEVELS AND THE MAGNETIC MOMENT OF THE ELECTRON. Arunasalam, V. (Princeton Univ., N. J.). Amer. J. Phys., 37: 877-81(Sept. 1969).

The change in the magnetic moment of the electron due to zero-point vibrations of the quantized radiation field is calculated from nonrelativistic quantum mechanics. Using ideas which underlie Bethe's calculation of the Lamb shift and Luttinger's calculation of the electron magnetic moment, but without using second quantization of the electron field, one obtains the familiar $g = 2[1 + (e^2/hc)]$. In addition, the calculation gives the correct form for the magnetic-field-dependent radiative corrections to g, namely a first term proportional to B and a second term proportional to B lnB. These B-dependent radiative terms differ only by numerical factors of the order of unity from the relativistic quantum electrodynamics corrections derived by Gupta. The self-energy integrals are fairly sensitive to the Bethe cutoff, but choosing the high-frequency cutoff at $\mu c^2/\hbar$ yields, simultaneously, the correct Lamb shift and the Schwinger g value. (auth)

20007 INTERPRETATION OF MEASUREMENT WITHIN THE QUANTUM THEORY. Cooper, Leon N.; Van Vechten, Deborah (Brown Univ., Providence). Amer. J. Phys.; 37: 1212-20(Dec 1969).

An interpretation of the process of measurement is proposed that can be placed wholly within the quantum theory. The entire system, including the apparatus and even the mind of the observer, can be considered to develop according to the Schroedinger equation. No separation, in principle, of the observer and the observed is necessary; nor is it necessary to introduce either the type I process of von Neumann or wave function reduction. (auth)

20008 UNIQUE HAMILTONIAN OPERATORS VIA FEYNMAN PATH INTEGRALS. Kerner, Edward H.; Sutcliffe, William G. (Univ. of Delaware, Newark). J. Math. Phys. (N. Y.); 11: 391-3 (Feb 1970).

The old problem of how to represent uniquely a prescribed classical Hamiltonian H as a well-defined quantal operator $\hat{H}$ is shown to have a clear answer within Feynman's path-integral scheme (as expanded by Garrod) for quantum mechanics. The computation of $\hat{H}$ involves the momentum Fourier transform of a coordinate average of H. A differential equation for a reduced form of the Feynman propagator giving $\hat{H}$ from H is found; and the example of polynomial H worked out to give the Born–Jordan ordering rule for $\hat{H}$ in this case. (auth)

20009 HIDDEN-VARIABLE THEORIES. Gudder, Stanley P. (Univ. of Denver). J. Math. Phys. (N. Y.); 11: 431-6(Feb 1970).

An abstract definition of a general hidden-variables theory is given, and it is shown that such a theory is always possible in the present framework of quantum mechanics and is, in fact, unique in a certain sense. It is noted that the Bohm–Bub hidden-variables example is contained in this theory and an attempt is made to clarify the position of this theory with respect to hidden-variable impossibility proofs. The general definition is used in the consideration of quantum-mechanical ordering and the measurement process. (auth)

20010 RADIATION OF ELECTROMAGNETIC WAVES BY CHARGED PARTICLES IN STATISTICALLY NONUNIFORM CRYSTALS. Begiashvili, G. A.; Monin, Yu. S. (Inst. of Cybernetics, Tbilisi, USSR). Sov. Phys.-Solid State (Engl. Transl.); 11: 1663-5(Feb 1970).

Translated from Fiz. Tverd. Tela; 11: 2057-61(Aug 1969).

The effect of spatial dispersion arising in statistically nonuniform media on the Čerenkov radiation of particles and particle beams moving through such media is studied. The possibility of exciting additional waves of the exciton type is shown. The frequency ranges where it is possible to excite the usual and the additional waves are determined. (auth)

20011 MONTE CARLO EVALUATION OF FEYNMAN PATH INTEGRALS IN IMAGINARY TIME. Lawande, Suresh Vencatesh. Davis, Calif.; Univ. of California (1969). 118p.

Thesis.

It is known that Feynman path integrals describe the space–time behavior of quantum mechanical systems, which they represent. In particular, if a system has well-defined stationary states, the path integral represents a superposition of all these states together with oscillatory time factors. By using imaginary time $\tau = it$, it is possible to reduce the Feynman path integral to a type of Wiener integral; the corresponding superposition of states now contains factors decaying exponentially in time. When evaluated over a sufficiently long time τ, this path integral yields, under suitable conditions, the ground state wave function of the quantum system. A numerical method of evaluating the many-dimensional Feynman path integrals in imaginary time is proposed. This method, which involves an importance sampling Monte Carlo integration scheme, is described in detail taking a one-dimensional harmonic oscillator as a test example. Applications of the method to obtain the ground-state wave functions and energies of some simple quantum sys-

tems are presented. The path integrals in some curvilinear coordinates are developed. In particular, path integrals in spherical polar coordinates are used to obtain the ground-state wave functions and energies of some quantum systems with spherically symmetric potentials of solvable types. The special cases of the isotropic oscillator and the attractive Coulomb potential are discussed. A brief description of the modifications necessary to take into account the effects due to quantum statistics is given along with some numerical results. (Diss. Abstr. Int., B)

20012 NOTE ON THE QUANTUM THEORY OF ELECTRIC AND MAGNETIC CHARGES. Efinger, H. J. (Univ. of Georgia, Athens). Physica; 44: 621-2(3 Nov 1969).

A quantization rule for the product of electric and magnetic charges can be easily obtained from Schroedinger's equation, which is solved under the condition that an electric charge is interacting with a uniform magnetic field produced by a plane sheet of magnetic charge. (auth)

20013 PHASE EQUATION FOR THE JOST FUNCTION. Janev, R. K. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Phys. Lett., 30A: 233(Oct. 20, 1969).

Using the variable phase method a Riccati equation for the Jost function is derived. (auth)

20014 RELATIVISTIC GENERALIZATION OF THE "MODIFIED APW METHOD". Hofmann, I.; Bross, H. (Univ., Munich). Z. Phys., 229: 123-30(1969). (In German).

A relativistic generalization of the "modified augmented-plane-wave method" is presented. It permits application to the exact Dirac Hamiltonian as well as to approximated two-component Hamiltonians. The method produces spinors which are everywhere continuous with continuous derivates which are particularly important for the relativistic case. (auth)

20015 A SPECIAL CASE OF VAVILOV–CHERENKOV RADIATION. Obdrzalek, J. (Charles Univ., Prague). Czech. J. Phys.; 19: 1556-61(1969).

The problem of Vavilov–Cherenkov radiation in an electrically biaxial crystal if a charge moves in the direction of one of the axes of the tensor of the dielectric constant is solved. In the notation, the equations for the Vavilov–Cherenkov cones, the direction radiation densities in the various cones, their sum, and the total radiation are determined. The dependences are discussed in great detail. In the computations, "untraditional" use has been made of a computer for the modification of algebraic expressions. (auth)

20016 FERMION OPERATOR ORDERING AND THE QUANTUM c-NUMBER CORRESPONDENCE. Mehta, C. L.; Jaiswal, A. K. (Univ. of Rochester, N. Y.). Amer. J. Phys.; 37: 1239-41(Dec 1969).

The linearly ordered and the exponentially ordered forms of an arbitrary spin-½ fermion operator are defined and evaluated. As an application an expression for exp $(\alpha\hat{b})$ exp $(\beta\hat{b}^{\dagger})$ is evaluated, which resembles the usual Baker–Hausdorff identity. It is shown that the trace of the product of two fermion operators can be expressed as a three-dimensional integral over c-number functions. Further the quantum equations of motion are also expressible as equations involving c-number functions. (auth)

20017 CONCERNING THE ENERGY INDEPENDENCE OF THE VELOCITY OF LIGHT. Brown, B. C. (Univ. of California, San Diego, La Jolla). Nature (London); 224: 1189(20 Dec 1969).

Reference is made to several communications purporting to contain new evidence of the energy independence of "c"; these contain statements that should be clarified. Care must be taken to analyze experimental work in terms of concepts that are valid only if relativity is correct. In examing tests of the relativity postulate, the frequency range explored and the experimental accuracy are independent figures of merit unless a model of violation is introduced. Physical models have been proposed that violate the energy independence postulate, and a model which involves a photon mass has been widely discussed and tested; this model is consistent with relativity. Classes of models involving nonlocal interactions have also been suggested and formulae devised for some. Reference is also made to the parameter "p" of Lovell, Whipple, and Solomon (Nature 202: 377 (1964)). Until, however, a deviation from accepted electrodynamics and relativity concepts is observed, no such model can be favored. Improvements in the accuracy and frequency range remain orthogonal and experiments that make improvements in either direction enlarge the realm of physics in which relativity can be used with experimentally tested assurance. (UK)

20018 TABLE OF INTEGRALS OF THE EXPONENTIAL INTEGRAL. Geller, Murray; Ng, Edward W. (California Inst. of Tech., Pasadena). Contract NAS7-100. J. Res. Nat. Bur. Stand., 73B: 191-210(July-Sept. 1969).

This is a compendium of indefinite and definite integrals of products of the exponential integral with elementary or transcendental functions. A substantial portion of the results is new. (auth)

20019 ON THE NUMERICAL SOLUTION OF HARTREE–FOCK EQUATIONS INDEPENDENT OF COUPLING SCHEME. Karazija, R.; Bogdanovicius, P.; Jucys, A. (Inst. of Physics and Mathematics, Vilnyus, USSR). Acta Phys. Acad. Sci. Hung.; 27: 467-75(1969).

The solution of Hartree–Fock equations by a numerical method on computers, type BESM, is described. The minimization of the input information is reached by using the equations independent of coupling scheme and the universal potential field for obtaining the initial radial wave functions. The results obtained are compared with those evaluated from the solutions of conventional Hartree–Fock equations. (auth)

20020 RADIATION FROM SYSTEMS IN NEARLY PERIODIC MOTION. Infeld, L.; Michalska-Trautman, R. (Inst. of Physics, Warsaw). Ann. Phys. (N.Y.); 55: 576-86(Dec. 1969).

Under the assumption of small influence of radiation on the motion, a simple formula for the energy radiated from a system of particles is derived from an action principle of a general type. The formula is applied to the problem of electromagnetic and gravitational radiation and the corresponding expressions for the radiated energy are discussed. The method is illustrated on the simple example of the motion of a charged particle in an external magnetic field. (auth)

20021 THE TRANSPORT COEFFICIENTS OF A FERMI LIQUID. Sykes, J. (Duke Univ., Durham, N. C.); Brooker, G. A. Ann. Phys. (N. Y.); 56: 1-39(Jan 1970).

Exact expressions are derived for the transport properties of a degenerate Fermi liquid. These expressions are obtained by solving certain integral equations which were first derived by Abrikosov and Khalatnikov and by Hone. The coefficients of shear viscosity, thermal conductivity, diffusion, and second viscosity, are derived; a later paper deals with sound propagation. The solutions obtained here for shear viscosity and diffusion agree within 25% with those originally quoted. However, the thermal conductivity is reduced by a factor of about 2. The coefficient of second viscosity does not seem to have been calculated previously; here it is shown that it varies with temperature like T^2. Applications of the present theory to liquid ^{3}He and ^{3}He–^{4}He mixtures are discussed, but numerical work reported by other authors has not been duplicated. Apart from having application to Fermi liquids, the exact solution described here is of general interest because it provides transport theory with a new soluble model. (auth)

20022 VIOLATION OF THE SUPERSELECTION RULES. Lubkin, Elihu (Univ. of Wisconsin, Milwaukee). Ann. Phys. (N. Y.); 56: 69-80(Jan 1970).

If $Q = \sum_{i=1}^{n} Q_i$, and $Q_i = 1_1 \otimes \ldots \otimes 1_{i-1} \otimes q_i \otimes 1_{i+1} \otimes \ldots \otimes 1_n (Q_i, Q_i$ form an additive system of quantities), if $[Q, P] = 0$ (superselection rule), and if the reduced density matrix ρ_i is obtained from the density matrix P by tracing out over the j-spaces, $j \neq i$, then $[q_i, \rho_i] = 0$. This shows that a superselection rule for an additive quantity propagates to subsystems. It is argued that superselection rules are therefore universal for additive quantities, unless a process of relativization with respect to a Q reservoir is employed. Since such relativization is required to produce the coherent superpositions of momentum eigenstates needed for the notion of localization in position, it is argued that analogous processes of relativization can be used to break other superselection rules. (auth)

20023 APPLICATION OF SOME INTERPOLATING FUNCTIONS IN PHYSICS. Jerri, A. J. (Clarkson Coll. of Tech., Potsdam, N. Y.). J. Res. Nat. Bur. Stand., 73B: 241-5(July-Sept. 1969).

J. M. Whittaker considered interpolating equidistant samples by using the cardinal series. Here the extension provided by the generalized sampling theorem of Kramer for nonequidistant samples is considered. Some sampling functions are calculated for cases of interest in mathematical physics. In particular, this includes the S-matrix contribution due to Regge poles, especially when a series expansion other than that of Fourier-Legendre type is needed. (auth)

20024 ANALYSIS OF THE PRINCIPLE OF MINIMAL ELECTROMAGNETIC INTERACTION. Petras, M. (Komensky Univ., Bratislava). Czech. J. Phys.; 19: 1562-9(1969).

The meaning and contents of the principle of minimal electromagnetic interactions are analyzed in the framework of the classical electrodynamics of a point charged particle. The essence of

this analysis consists in expressing the free electromagnetic field as a difference of retarded and advanced fields and in observing the effect of switching on the minimal coupling on the retarded field. A new equivalent formulation of this principle is given and the possibility of its generalization is suggested. (auth)

20025 VARIATIONAL PROCEDURE WITH ORTHOGONALIZATION PSEUDO-HAMILTONIANS. Cada, J. (Inst. of Solid State Physics, Prague). Czech. J. Phys., 19: 1061-6(1969).

For the case of Hamiltonians with possibly non-Hermitian repulsive potential, the applicability is shown of the actual scheme used for construction of the variational expression in the eigenvalue problem with Hermitian operator. The hydrogen atom up to the 4d-state is numerically solved with four such pseudo-Hamiltonians using the same trial function, which yields possibility of comparison. (auth)

20026 PHOTON TRANSMISSION THROUGH A HOT ELECTRON ATMOSPHERE. Erdmann, R. C. (Univ. of California, Los Angeles); Pomraning, G. C. J. Quant. Spectrosc. Radiative Transfer; 10: 133-41(Feb 1970).

The problem of steady-state photon transmission through a planar atmosphere of free electrons is considered. The electrons are assumed to be in a local Maxwellian distribution with a density that is independent of position. The photons are allowed to undergo Compton and inverse Compton scattering. The quantities of interest are taken to be the spectral distribution of the transmitted flux and the temperature distribution through the atmosphere. That is, the interaction between photons and electrons is allowed to drive the local electron temperature to just that value such that no energy exchange takes place between electrons and photons. The analysis shows that the temperature can either increase or decrease as one traverses the atmosphere, depending upon the spectral distribution of the incoming flux. (auth) (UK)

20027 PROBLEM OF THE RELATION BETWEEN QUANTUM MECHANICS AND THE THEORY OF RELATIVITY. Akulov, N. S. (Dept. of Physics of Nondestructive Control, Minsk). Dokl. Akad. Nauk BSSR; 13: 886-9(Oct 1969). (In Russian).

The CTO corollary on the rate of point charge motion and possibility of its rectilinear motion, which does not agree with the Dirac equations, is discussed. An additional condition was suggested for the CTO postulate stating that the charges move with the speed of light, c. The spectrum of their rotation ω_k in which the second line determines the electron mass m_e and the first, together with the second, determines the hadron mass is introduced. The mass of all elementary particles is determined by the formula $mc^2 = n_0\hbar\omega_0 + n_1\hbar\omega$, when n_0 and n_1 are whole numbers determined on the basis of the Pauli principle and the elementary-particle shell model. The theory proposed offers the means for quantitative calculations of elementary-particle mass, mode of decay, and energy bond, suggests radii of certain orbits, and reveals the essence of the baryon number singularity. (tr-auth)

20028 SEPARATION CO-ORDINATES AND DYNAMICAL SYMMETRIES. Onofri, E.; Pauri, M. Univ. Parma, Italy). Nuovo Cim., Lett.; 2: 607-13(1 Nov 1969).

It is shown how it is possible to find out the whole family of orthogonal coordinate systems in which the Hamilton–Jacobi equation for a completely degenerate dynamical system admits separation; it will be sufficient to know all the independent constants of motion of the problem or, more specifically, a maximal symmetry algebra globally defined in the phase space of the system. Only the case of two degrees of freedom is considered. (M.O.W.)

20029 MONTE CARLO EVALUATION OF FEYNMAN PATH INTEGRALS IN IMAGINARY TIME AND SPHERICAL POLAR COORDINATES. Lawande, S. V.; Jensen, C. A.; Sahlin, H. L. (Univ. of California, Livermore. Univ. of California, Davis). J. Comput. Phys.; 4: 451-64(Dec 1969).

Feynman path integrals in imaginary time are developed for a particle moving under a central field, using spherical polar coordinates. Evaluation of these integrals using a method presented previously is employed to obtain the ground states and energies of some quantum mechanical systems with spherically symmetric potentials of solvable types. In particular, the cases of the isotropic oscillator and the attractive Coulomb potential are discussed. (auth)

20030 SOLUTION OF A SCHROEDINGER EQUATION WITH A NONLOCAL POTENTIAL. Reeves III, M. (Union Carbide Corp., Oak Ridge, Tenn.); Owen, L. W. J. Comput. Phys.; 4: 572-8(Dec 1969).

A separable-potential-subtraction method is presented which yields solutions for the scattering of a particle from a nonlocal potential. This technique is then compared to the simultaneous-equations method of Robertson with respect to speed, accuracy, and reliability. (auth)

20031 VECTORIAL METHODS IN QUANTUM MECHANICS. I. VECTORIAL SOLUTION TO SOME MOTION PROBLEMS IN CLASSICAL MECHANICS. Bleuler, Konrad (Univ., Bonn); Kustaanheimo, Paul E. Ann. Acad. Sci. Fenn., Ser. A VI; No. 258, 1-13(1968). (In German).

The Kepler motion, the motion of an electric charge in the field of a magnetic monopole, and the 3-dimensional harmonic oscillator possess simple vector and tensor integrals with five independent components which describe the orbit completely. All characteristic quantities of these orbits (focal points a.s.o.) are obtained directly from the initial position and velocity with the help of natural geometrical interpretations of these integrals. In the case of an external perturbation the time-dependence of the integrals is determined by a system of differential equations which is given explicitly for each case by means of vectorial methods. The intimate connection between the complete set of integrals and the characteristic group belonging to each problem is discussed. (auth) (Finland)

20032 ON THE STRUCTURE OF THE MAXWELL EQUATIONS. Bleuler, Konrad (Univ., Bonn); Kustaanheimo, Paul E. Ann. Acad. Sci. Fenn., Ser. A VI; No. 298, 1-17(1968).

In view of the great importance of the reflection properties of physical laws it is stressed that the structure of the Maxwellian system is, to some extent, determined from the principle of parity conservation. These considerations lead in a natural way to the more compact, complex form of the field equations; this new system is written in terms of the combined field $\overline{F} = \overline{E} + i\overline{B}$ which exhibits interesting transformation properties. In fact, the space reflection $x \rightarrow -x$ is now represented by the transition to the complex conjugate field, whereas the transformations of $\overline{F}$ according to the proper Lorentz group are given by the 3-dimensional irreducible and complex representation of the type (1, 0). This transformation law can be replaced, however, by the 2-component Weyl representation ($\frac{1}{2}$, 0) if the field $\overline{F}$ is expressed by a "relativistic motor," i.e. a two-by-two matrix F based on Pauli's matrices σ: $F = (\overline{\sigma} \cdot \overline{F})$. This most convenient concept also leads immediately to the even more concentrated matrix-form of the Maxwellian system, i.e. a single matrix equation which exhibits a striking similarity to the Weyl neutrino law. In addition, all characteristic quantities of the theory (potentials and interactions) can be written in terms of the corresponding matrices (i.e. motors) whereby the relativistic invariance of all relations becomes evident. It is emphasized, however, that the conventional tensor-form (and its natural generalization for a manifold) plays a decisive role in the framework of general relativity where a much deeper understanding of the Maxwellian structure is reached. It thus becomes evident that the Maxwellian field is simultaneously related to the realm of cosmological dimensions as well as to the microscopic domain of atoms and nuclei where spinors play a decisive role. (auth)

20033 AN INSTRUCTIVE EXAMPLE OF THE SUDDEN APPROXIMATION IN QUANTUM MECHANICS. Schlitt, D. W.; Stutz, C. (Univ. of Nebraska, Lincoln). Amer. J. Phys.; 38: 70-5(Jan 1970).

Some features of the sudden approximation are examined and applied to the example of a particle in a suddenly expanded box. Among the points illustrated are the form of the work energy relation in quantum mechanics, the application of the energy–time uncertainty relation, some pitfalls in the use of theorems that apply only to Hermitian operators, and the periodic time dependence of expectation values. (auth)

20034 REDUCTION OF WAVE FUNCTIONS WHICH TRANSFORM AS A COMPLEX ANTISYMMETRIC TENSOR TO THE IRREDUCIBLE REPRESENTATION OF LORENTZ GROUP. Rajput, B. S. (Kurukshetra Univ., India). Indian J. Phys. 43: 135-46 (Mar 1969).

The reduction of the wave function, which transforms as a complex antisymmetric tensor to the irreducible representation of proper orthochronous inhomogenous Lorentz group, is discussed by giving proof of the essential theorem which is used for the reduction. The effects of the reality condition and wave equation are also discussed, where the former reduces the expression to that of real wave function, which transforms as a real antisymmetric tensor while the latter restricts the number of independent irreducible representations. By assuming the total energy to be positive, the constants of the expansion of wave function that satisfy the wave equation are calculated to give the energies for the cases corresponding to positive and negative values of Hamiltonian density. (auth)

20035 ELASTIC MORSE SCATTERING. Krori, K. D. (Cotton Coll., Assam, India); Sen Gupta, Krishna. Indian J. Phys.; 43: 128-34(Mar 1969).

Some calculations are presented here on elastic scattering by Morse potentials by some well-known methods. The influence of the Coulomb field on Morse scattering is discussed in the first approximation, and the Schroedinger equation for S-wave scattering is solved rigorously. (auth)

20036 CHERENKOV RADIATION IN A WAVE-GUIDE LOADED WITH A MOVING MEDIUM. Khan, R. M. (City Coll., Calcutta) Indian J. Phys.; 43: 156-63(Mar 1969).

The field of a charge moving along the axis of a cylindrical waveguide, which is filled with a moving dielectric, is obtained. Simple expressions are derived for the total energy loss due to the Cherenkov radiation and the excitation of plasma waves. The energy of the continuous spectrum is found to be concentrated at certain discrete frequencies, as is usually the case in a waveguide. (auth)

20037 ALTERNATIVE TO PERTURBATION THEORY. Niblack, W. K. (State Univ. of New York, Buffalo); Nigam, B. P. Amer. J. Phys.; 38: 101-8(Jan 1970).

A matrix method alternative to perturbation is proposed. The method is applicable even when some of the off-diagonal elements of the Hamiltonian are large; it does not require a nondegenerate "unperturbed Hamiltonian." The method proposed is not a perturbation theory in the usual sense, since it does not require the interaction potential to be small, and its convergence or lack of convergence can be determined during the course of the calculations, since the method depends on an iterative procedure. (auth)

20038 LECTURES ON K(X). Bott, Raoul. Mathematics Lecture Note Series. New York; W. A. Benjamin, Inc. (1969). 212p. $12.50.

The theory of characteristic classes is developed in both the standard cohomology theory and K theory. Systematic use is made of induced representation theory and the resulting formulas for the KO theory of sphere bundles. The Chern classes and allied functions on bundles, the Thom homomorphism for K(X), the obstruction to coreducibility, the representative ring of a group, the RO of a compact Lie group, induced representations, and the periodicity theorem for KO are treated. Also included are sphere bundles, the Thom isomorphism, the Gysin sequence, the rational J-invariant derived from $\theta(V)$, real projective bundles, and the different element. (J.F.P.)

20039 ELECTRON MOTION IN HOMOGENEOUS ELECTRIC AND MAGNETIC FIELDS. Kaczmarczyk, J. (Warsaw Polytechnic). Arch. Elektrotech. (Warsaw); 18: 619-28(1969). (In Polish).

General equations, in a form convenient for computation, as well as basic parameters of the electron motion in homogeneous electric and magnetic fields are presented. The possibility of easy determination of the electron path projection on coordinate planes in a rectangular system is also considered on the basis of the discriminator κ introduced in the paper. Finally, the dependence of basic parameters of the electron path on the starting data, i.e., on the initial velocity of the electron and vectors of electric field strength and magnetic field induction, is discussed. (auth)

20040 ABOUT QUANTUM MEASUREMENTS. Jasselette, P. (Univ., Liege). Lett. Nuovo Cim.; 3: 13-14(1 Jan 1970).

Recent controversy on interpretation of quantum mechanics, wherein various authors seek a really "realistic" model for the measurement process, is briefly discussed. The author feels that this way of reasoning does not seem to be compatible with the basic features of quantum mechanics. (L.M.T.)

20041 SPECTRAL DISTRIBUTION OF TRANSITION RADIATION OF RELATIVISTIC ELECTRONS. Alikhanyan, A. I.; Ispiryan, K. A.; Oganesyan, A. G. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 233-5(1969). (In Russian).

The results of the experimental investigation of the transition radiation by electrons with energies of 20 to 60 MeV in a glass plate in a wavelength region of 3400 to 6000 Å are given. (auth)

20042 ON THE THEORY OF FERMION DENSITY OPERATORS. I. THE DEFINITION OF THE ONE-PARTICLE STATES AND CLUSTER EXPANSIONS OF THE DENSITY OPERATORS. Horvath, J. I.; Gyemant, I. K. (Jozsef Attila Univ., Szeged). Acta Phys. Acad. Sci. Hung.; 27: 111-29(1969).

After the definitions of density operators, the concept of single particle states is defined via the pure states of the first order reduced density operators. Then the concepts of the NSO's and NSG's, as well as expansions in their terms are treated. Furthermore, Kiang's variational approach is discussed and improved. Finally, cluster expansions of the N-particle density operators are obtained in terms of the first order reduced density operators in various cases. (auth)

20043 APPROXIMATION OF LINEAR TRANSPORT PROCESSES. Hejtmanek, H. J. (Univ. of Colorado, Boulder). J. Math. Phys. (N. Y.); 11: 995-1000(Mar 1970).

The semigroup generated by the linear transport operator is approximated by the corresponding discrete linear transport process. It can be shown that, in the case of a 2-dimensional μ space (x,μ), the generating operators converge and the discrete linear-transport process is uniformly quasibounded. A stability condition can be formulated.

20044 ONE-DIMENSIONAL N-BODY PROBLEM WITH δ-INTERACTION. Jannussis, A. D. (Univ. of Patras, Greece). Z. Naturforsch.; 25a: 127-34(Jan 1970).

The one dimensional N-body problem was studied with delta-function interaction and width 2 C. To determine the ground-state energy and the excitation spectrum, one arrives at integral equations similar to the equation of Hulthen. The solution of the integral equation is achieved by the moments method and the results are compared with those found in the literature. (auth)

20045 QUANTUM STOCHASTIC PROCESSES. Davies, E. B. (Inst. for Advanced Study, Princeton, N. J.). Commun. Math. Phys.; 15: 277-304(30 Dec 1969).

In order to describe rigorously certain measurement procedures, where observations of the arrival of quanta at a counter are made throughout an interval of time, it is necessary to introduce the concept of a quantum stochastic process. While fully quantum mechanical in nature, these have a great deal of similarity with classical stochastic processes and can be characterized by and constructed from their infinitesimal generators. The infinitesimal generators are naturally obtained from certain "fields" which must be of the boson or fermion type. (auth)

20046 DIMENSIONALITY EFFECTS ON THE FERMI GAS. Kapron, Felix P. (Corning Glass Works, N. Y.). Amer. J. Phys.; 38: 216-17(Feb 1970).

It is shown how the elementary properties of one-, two-, and three-dimensional free electron gases may be obtained as special cases of a general formulation. The exercise is suitable for a student and furthermore suggests that the concept of nonintegral dimensionality may serve to describe finite geometries as intermediate between the usual integral types. (auth)

20047 EFFECTS OF COULOMB INTERACTIONS ON THE LANDAU DIAMAGNETISM. Isihara, A. (Argonne National Lab., Ill.); Wadati, M. Phys. Rev., A; 1: 318-20(Feb 1970).

The diamagnetic susceptibility of an electron gas is reduced by Coulomb interactions below the Landau value in proportion to $\epsilon\beta\kappa_0^2$, where ϵ is the plasma parameter, κ_0 is the Debye screening constant, and $\beta = 1/kT$. (auth)

20048 AHARONOV–BOHM EFFECT: QUANTUM EFFECTS ON CHARGED PARTICLES IN FIELD-FREE REGIONS. Erlichson, Herman (Staten Island Community Coll., N. Y.). Amer. J. Phys.; 38: 162-73(Feb 1970).

The Aharonov–Bohm effect is relatively little known, but it poses fundamental questions in quantum theory. It concerns physical effects on charged particles in field-free regions. The present paper provides an over-all critical review and commentary on the literature of the Aharonov–Bohm effect. The two fundamental questions raised by the effect concern the role of the force concept in quantum mechanics, and the localizability of physical effects principle. A recent letter from Professor Bohm concerning his evaluation of the significance of the effect is included in the Appendix. (auth)

20049 LOW-FREQUENCY BREMSSTRAHLUNG IN COULOMB SCATTERINGS OF NONRELATIVISTIC ELECTRONS. Gould, Robert J. (Univ. of Sydney). Amer. J. Phys.; 38: 189-95(Feb 1970).

A simplified derivation of the low-frequency bremsstrahlung cross section in the classical limit is presented. Also, by expanding Elwert's exact quantum-mechanical expression for the cross section in powers of $(Ze^2/\hbar v)^2$ and in powers of $\hbar v/Ze^2$, corrections are obtained to the Born-limit and classical formulas, respectively. Averaging over a Maxwellian distribution of incident electrons gives the low-frequency thermal emission and absorption coefficients; corrections to the Born limit and classical formulas are expressed as power series in Z^2 Ry/kT and $(kT/Z^2\ Ry)^{\frac{1}{2}}$, respectively. Significantly, the coefficient of the first-order correction

term for the classical formulas for the cross section and thermal coefficients turns out to be zero. (auth)

20050 TRAJECTORY OF CHARGED PARTICLES IN WEAKLY INHOMOGENEOUS MAGNETIC FIELDS. Cook, David M. (Lawrence Univ., Appleton, Wis.). J. Math. Phys. (N. Y.); 11: 986-94 (Mar 1970).

The detailed time dependence of the trajectory, and particularly of the acceleration, of a charged particle moving nonrelativistically in a weakly inhomogeneous, slowly varying electromagnetic field is calculated by a method that involves superimposing a conventional perturbation expansion in the weak field on the expansion of Berkowitz and Gardner and of Kruskal, the latter expansion being asymptotically valid in the limit of small Larmor radius and slowly varying fields. Fourier transforms are introduced to facilitate isolation of rapidly varying terms from the most general solutions for the coefficients in the expansion. The calculations are carried to first order in the weak inhomogeneity and (at least formally) to all orders in Larmor radius. The resulting velocity reproduces the familiar transverse drift velocities of first-order orbit theory, emphasizes that in the presence of fields varying slowly in time the polarization and curvature drifts are to be calculated from the time derivative of the fields as seen from a frame of reference fixed with respect to the guiding center of the particle's orbit, and permits calculation of higher-order contributions to the drift velocities, contributions of second order in Larmor radius being explicitly evaluated; the resulting acceleration prepares the way for a study of the effect of weak inhomogeneities on the radiative output of single particles. (auth)

20051 ON LIMITS OF SEPARABLE POTENTIALS AND OPERATOR EXTENSIONS. Breitenecker, M.; Gruemm, H. R. (Univ., of Vienna). Commun. Math. Phys.; 15: 337-48(30 Dec 1969).

A family of self-adjoint Hamiltonians with a separable potential leading towards a contact potential (zero range) is analyzed by tools of functional analysis. It is shown that the family of time evolution operators e^{-iHt} converges strongly (for all t) though the family of Hamiltonians does not converge even weakly. In the case of three dimensions, a renormalization procedure is discussed and a correspondence between the renormalized coupling constant and the self-adjoint extensions of the free Hamiltonian is established. (auth)

20052 SOLUTION OF THE COMPLEX HARTREE–BOGOLYUBOV EQUATIONS BASED ON DIAGONALIZATION OF REAL MATRICES. Vujicic, M.; Herbut, F. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Nuovo Cim.; 65B: 221-8(11 Feb 1970).

The general Hartree–Bogolyubov complex equations are solved by an iterative diagonalization of a real symmetric matrix making use of an antilinear matrix inherent in Hartree–Bogolyubov theory. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 20272.

20053 NUCLEAR AND PARTICLE PHYSICS ANNUAL. VOLUME 1 (1967). A CRITICAL DISCUSSION OF THE LITERATURE. Lederman, Leon; Weneser, Joseph. New York; Gordon and Breach, Science Publishers, Inc. (1969). 219p.

Forty-five expositions are presented by leading physicists on the developments and important trends in nuclear and particle physics in their area of specialization. Comments are made on work appearing in the current literature. The book is intended to provide a guide to the literature and progress in physics, and to restore, in some measure, the traditional unity of physics. (L.B.S.)

20054 REVIEW OF PARTICLE PROPERTIES. Barbaro-Galtieri, Angela (Univ. of California, Berkeley); Derenzo, Stephen E.; Price, Leroy R.; Rittenberg, Alan; Rosenfeld, Arthur H.; Barash-Schmidt, Naomi; Bricman, Claude; Roos, Matts; Soeding, Paul; Wohl, Charles G. Rev. Mod. Phys.; 42: 87-200(Jan 1970).

This review of the properties of leptons, mesons, and baryons is an updating of Review of Particle Properties, Particle Data Group [Rev. Mod. Phys. 41, 109 (1969)]. Data are evaluated, listed, averaged, and summarized in tables and wallet sheets. A data booklet is also available. (auth)

Electromagnetic

Refer also to abstract 20083.

20055 (DESY-69/50) PHOTOPRODUCTION OF NEUTRAL RHO MESONS. Alvensleben, H.; Becker, U.; Bertram, William K.; (and others) (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Massachusetts Inst. of Tech., Cambridge). Dec 1969. 48p. Dep. CFSTI (U. S. Sales Only).

Results of measurements on the photoproduction of mesons (ρ^0) are presented. An analysis of 10^5 measured π pairs on protons in the energy region 2.6 to 6.8 GeV using various assumptions of ρ production indicates that $d\sigma/dt(t = 0)$ decreases with increasing energy similar to $\pi-N$ scattering. An analysis of 10^6 measured π pairs from 13 complex nuclei in a four-dimensional data matrix $d\sigma/d\Omega\, dm\ (A,m,p,t_\perp)$ with dimensions 13, 20, 6, 60 yields precise information on nuclear density distributions determined by ρ production. For the Wood-Saxon radii $R(A) = (1.12 \pm 0.02)\, A^{\frac{1}{3}}$ fm and, using the vector dominance model, $\sigma_{\rho N} = 26.7 \pm 2.0$ mb and $\gamma_\rho^2/4\pi = 0.57 \pm 0.10$. (auth)

20056 (LAL-1229) PRODUCTION OF ω VECTOR MESONS BY ELECTRON-POSITRON ANNIHILATION (DETECTION OF THE MODE $\pi^+\pi^-\pi^0$). INDICATION OF AN INTERFERENCE $\rho^0-\omega$ IN THE MODE $\pi^+\pi^-$. Laplanche, Francis ([Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire]). Jan 1970. 77p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

Spark chambers and scintillation counters were used to study the interactions $e^+ + e^- \rightarrow \pi^+ + \pi^- + \pi^0$ and $e^+ + e^- \rightarrow \pi^+ + \pi^-$ in colliding beams. Meson (ω) production is found in the first interaction, and $\rho^0-\omega$ interference is found in the second. The cross section is given for the $e^+ + e^- \rightarrow \pi^+ + \pi^- + \pi^0$ interaction, and the branching ratio and partial width of the ω in $e^+ + e^-$ interactions are determined. (J.F.P.)

20057 ULTRARELATIVISTIC ELECTRON IONIZATION IN NUCLEAR EMULSIONS. Batthyany, Yvan; Bernheim, Albert; Charquet, Bernard; Van Hollebeke, Michele; Morand, Max (Faculte des Sciences, Paris). Compt. Rend., Ser. B; 269: 655-8(6 Oct 1969). (In French).

The ionization produced by ultrarelativistic particles was studied for electrons with $\gamma > 1000$ from the mean of gap distribution measurements. This study was carried out on 1.70 M of electron tracks corresponding to a statistical volume of $2.5(10)^5$ gaps. The gap distribution law is of the form $f(x) = 1/\lambda \exp(-x/\lambda)$. The mean ionization represented by the parameter λ seems to show a slight variation between 1 and 2 GeV/c. (tr-auth)

20058 SECONDARY PARTICLE PRODUCTION IN HIGH-ENERGY MUON-NUCLEON INTERACTIONS. Jain, P. L.; Malucci, R. D.; Potoczak, M. J. (State Univ. of New York, Buffalo). Phys. Rev. Lett.; 24: 526-9(9 Mar 1970).

Secondary particles produced by muon-nucleon interactions at 10.1 GeV/c (positive) and 14.6 GeV/c (negative muons) were identified in nuclear emulsions. The energy spectrum and angular distribution (in c.m. system) are given for pion, kaon, and proton along with their partial cross sections. Yang's hypothesis of limiting fragmentation in high-energy lepton-hadron collision is compared with our results which tend to support it. (auth)

20059 MUON-NUCLEON INELASTIC SCATTERING, q^2 LESS THAN 1 $(GeV/c)^2$. Jain, P. L.; Malucc, R. D.; Potoczak, M. J. (State Univ. of New York, Buffalo). Phys. Rev. Lett.; 24: 530-4 (9 Mar 1970).

The inelastic scattering of muons was measured using 10.1 GeV/c positive and 14.6-GeV/c negative muons in nuclear emulsion. The partial and integral cross sections were measured for both beams along with the energy dependence of their total cross sections. Experimental values are compared with the theory by using three different forms, i.e., first, second, and fourth power of $m_\rho^2/(m_\rho^2 + q^2)$ for $\sigma_{expt}(q^2,\nu)$, the quantity commonly called the "virtual photon-nucleon total cross section." (auth)

20060 BRANCHING RATIOS WITHIN THE NEUTRAL DECAYS OF THE η^0 MESON. Cox, B.; Fortney, L.; Golson, J. (Duke Univ., Durham, N. C.). Phys. Rev. Lett.; 24: 534-7(9 Mar 1970).

The neutral decays of η^0 mesons produced in a hydrogen bubble chamber are studied. Utilizing the conversion within the chamber of one photon from each decay, the following percentages of the neutral decays are obtained; $(\eta^0 \rightarrow \gamma\gamma)/(\eta^0 \rightarrow \text{neutrals}) = (48.6 \pm 3.6)$ %, $(\eta^0 \rightarrow \pi^0\gamma\gamma)/(\eta^0 \rightarrow \text{neutrals}) = (12.2^{+4.5}_{-3.4})$ %, and $(\eta^0 \rightarrow 3\pi^0)/(\eta^0 \rightarrow \text{neutrals}) = (39.2 \pm 4.2)$%. With the assumption of no $\pi^0\gamma\gamma$ contribution, the ratio $(\eta^0 \rightarrow 3\pi^0)/(\eta^0 \rightarrow \gamma\gamma) = 0.91 \pm 0.14$ is obtained. (auth)

20061 HIGH-ENERGY PHOTOPRODUCTION. Diebold, Robert E. (Argonne National Lab., Ill.). Comments Nucl. Particle Phys.; 3: 170-5(Nov-Dec 1969). (CONF-690928-2).

From 3rd International Conference on High Energy Reactions, Stony Brook, N. Y.

A review of high-energy photoproduction on protons is presented. Also photoproduction from complex nuclei is briefly considered. (J.F.P.)

20062 ELECTROMAGNETIC INTERACTIONS OF HIGH-ENERGY COSMIC-RAY MUONS. Binns, Walter Robert. Fort Collins, Colo.; Colorado State Univ. (1969). 93p.

Thesis.

A Wilson multiplate cloud chamber was operated underground at a depth of 274 m.w.e., to measure the muon knock-on and direct pair cross sections in lead and iron. Approximately 18,000 photographs of muon traversals were accepted as data. During the lead data run, 436 events above 175 MeV were obtained. In the iron data run, 270 events above 175 MeV were obtained. The underground muon spectrum was calculated by first obtaining the surface muon spectrum at the mine location. This was found to approximate very closely the measured sea level spectrum for energies of concern in this experiment. Experimentally verified energy loss relationships were then applied to obtain the underground muon spectrum. The theoretical values for the muon knock-on electron cross section were calculated from the Bhabha formula. The theoretical results of Murota, Ueda and Tanaka were used to obtain the predicted direct pair cross section. The underground muon spectrum was then folded into the theoretical cross sections to obtain the predicted number of events. Recent experimental and theoretical electron-photon shower curves were used to obtain the energy transferred in the events. Good agreement with theory was obtained for the sum of knock-on and direct pair events in both lead and iron for energy transfers below 960 MeV. However, a statistically significant anomalously large cross section was obtained in the energy transfer region of 2550 to 5280 MeV and possibly in the energy transfer interval 960-1470 MeV. This anomaly appears to reside in the knock-on interaction since the direct pair production depends on Z^2/A, whereas the knock-on interaction depends on Z/A. An examination of the experimental and theoretical methods used reveals that the excess of events above 1 GeV cannot be accounted for by any recognizable experimental bias or systematic error. The results of Deery and Neddermeyer, Hazen and Kearney, and Kotzer and Neddermeyer show agreement with the results of this experiment for energy transfers above 1 GeV. These results suggest further an examination of the cosmic ray muon knock-on electron process. (Diss. Abstr.)

20063 QUASIELASTIC SCATTERING OF HIGH-ENERGY ELECTRONS ON NUCLEONS OF ^{12}C AND ^{28}Si. Dementii, S. V.;

Afanas'ev, N. G.; Arkatov, I. M.; Vlasenko, V. G.; Gol'dshtein, V. A.; Kuplennikov, E. L. (Physical-Technical Inst., Kharkov). Yadern. Fiz.; 11: 19-28(1970). (In Russian).

Results are presented of measurements of inelastic scattering of electrons with energies 690, 970, and 1115 MeV on ^{12}C and ^{28}Si nuclei in the angle interval 16 to 40°. The results are analyzed with the theory of quasielastic scattering. It is shown that in order to make the present results compatible with the elastic scattering on the same nuclei it is necessary to account for inequality of potentials in different nuclear shells as well as the dynamical correlations of nucleons in nuclei. (auth)

20064 SHAPE OF ENERGY SPECTRUM OF δ-ELECTRONS KNOCKED OUT BY FAST CHARGE-UNITY PARTICLES FROM ATOMS OF ELEMENTS CONTAINED IN NUCLEAR PHOTOEMULSION. Skirda, N. V. Yadern. Fiz.; 11: 192-9(1970). (In Russian).

It is shown that the function describing energy distribution E' of δ electrons produced by a fast charge-unity particle passing through the photoemulsion, is a curve slowing down according to the $(E')^{-4}$ rule with a high-energy tail. The latter is from $E' \cong 5$–10 keV up to E'_{max} that is determined by the velocity of the particle and slows down according to the $(E')^{-2}$ rule. (auth)

Weak

Refer also to abstract 20129.

20065 (AD-697966) ANALYSIS OF 17,898 τ^+ MESON DECAYS AT REST. Grauman, J.; Koller, E. L.; Taylor, S.; Stamer, P.; Kanofsky, A. (Stevens Inst. of Tech., Hoboken, N. J. Dept. of Physics). 1969. 29p. CFSTI.

The energy spectrum of the decay pions in τ^+ decay was obtained from a sample of 17,898 events. It is found that the spectrum is adequately fitted by a squared matrix element of linear form. No evidence for CP noninvariance is found for τ^+ decays. A significant violation of the $\Delta I = 1/2$ rule is observed for K+ yields 3 pion decays. (auth)

20066 (UCRL-19397) MEASUREMENT OF THE BRANCHING RATIO $K_L^0 \to 2\pi^0/K_L^0 \to 3\pi^0$. Oliver, William P. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov 1969. Contract W-7405-eng-48. 57p. Dep. CFSTI.

Thesis.

The rate of the decay $K_L^0 \to 2\pi^0$ was measured relative to that of $K_L^0 \to 3\pi^0$ using a monoenergetic K_L^0 beam and a nearly 4π solid-angle detection system of lead-plate spark chambers and shower counters. The analysis of the fraction (40%) of the data at the Lawrence Radiation Laboratory gives for the branching ratio 0.0100 ± 0.0018 (statistical) $\pm$ 0.0009 (systematic). This result leads to a value for the branching ratio $[\Gamma(K_L \to 2\pi^0)]/[\Gamma(K_L \to \pi^+\pi^-)]$ of $1.37 \pm .25$ (statistical) $\pm$ .14 (systematic). The significant difference between this ratio and the ratio $[\Gamma(K_S \to 2\pi^0)]/[\Gamma(K_S \to \pi^+\pi^-)]$ implies that CP violation must occur at least in part in the $K^0 \to 2\pi$ decay process itself. (auth)

20067 LIFETIMES OF LIGHT HYPERFRAGMENTS AND THE π^+ TO π^- DECAY RATIO FOR $_\Lambda He^4$. Phillips, Richard Earl. Medford, Mass.; Tufts Univ. (1968). 192p.

Results of a study of the lifetimes of light hyperfragments and of the π^+ to π^- decay ratio for $_\Lambda He^4$ are reported. A total of 1218 π^- mesonic decays and 4 π^+ mesonic decays were found in an emulsion stack which had been exposed to 1.1 BeV/c K^- mesons at the Bevatron. The values obtained for the lifetimes are as follows: For $_\Lambda H^3$, using two and three body events, the lifetime obtained was $\tau(_\Lambda H^3) = (2.60^{+}) \times 10^{-10}$ sec. For $_\Lambda H^4$, separate lifetimes using two body and three body events are given. Using two body events the lifetime obtained was $\tau(_\Lambda H^4) = (3.1) \times 10^{-10}$ sec.; using three body events $\tau(_\Lambda H^4) = (3.34) \times 10^{-10}$ sec. was obtained. Because of the difficulty in separating $_\Lambda He^4$ from $_\Lambda He^5$ events, a combined $_\Lambda He^{4,5}$ lifetime was calculated in addition to the two separate lifetimes. For $_\Lambda He^4$ the lifetime obtained was $\tau(_\Lambda He^4) = (1.88) \times 10^{-10}$ sec.; for $_\Lambda He^5$ we found $\tau(_\Lambda He^5) = (3.04) \times 10^{-10}$ sec. The combined lifetime for $_\Lambda He^{4,5}$ was found to be $\tau(_\Lambda He^{4,5}) = (2.54) \times 10^{-10}$ sec. A careful analysis of the effect on these values of the division of ambiguous events was also made. Values of the lifetimes for all these hyperfragments were also calculated using the combined data of this experiment and the work done previously at Tufts. The values found were: $\tau(_\Lambda H^3) = (2.74) \times 10^{-10}$ sec.; $\tau(_\Lambda H^4) = (3.14) \times 10^{-10}$ sec. (three body only); $\tau(_\Lambda He^4) = (2.28) \times 10^{-10}$ sec; $\tau(_\Lambda He^5) = (2.51) \times 10^{-10}$ sec.; $\tau(_\Lambda He^{4,5}) = (2.43) \times 10^{-10}$ sec. In addition to the hydrogen and helium hyperfragments, a considerable number of lithium hyperfragments including one in flight was observed, enabling a lower limit to be set for the lifetime, $\tau(_\Lambda Li^8) \geq 1.21 \times 10^{-10}$ sec. Of the four π^+ decay events found, three were of the hyperfragment $_\Lambda He^4$. Combined with 185 ± 52 $_\Lambda He^4$ hyperfragments which decayed via the π^- mode, a value of $(1.6 \pm 1.3)\%$ is obtained for the π^+ to π^- ratio for $_\Lambda He^4$. The results for the lifetimes and the π^+ to π^- decay ratio are discussed with respect to theoretical estimates and other experiments. (Diss. Abstr.)

20068 ASTROPHYSICAL DETERMINATION OF THE COUPLING CONSTANT FOR THE ELECTRON–NEUTRINO WEAK INTERACTION. Stothers, Richard B. (Goddard Inst. for Space Studies, New York). Phys. Rev. Lett.; 24: 538-41(9 Mar 1970).

The existence of the $(\bar{e}\nu_e)(\bar{\nu}_e e)$ weak interaction is confirmed by the results of nine astrophysical tests. The value of the coupling constant is equal to, or close to, the coupling constant of beta decay, namely, $g^2 = 10^{\pm 1/2} g_\beta^2$. (auth)

20069 ANALYSIS OF 15,865 τ^+ DECAYS AT REST. Grauman, Joseph Uri. Hoboken, N. J.; Stevens Inst. of Tech. (1969). 53p. Thesis.

The energy spectrum of the like and unlike pions in τ^+ decay was obtained from a sample of 15,865 events. It is found that the π^- spectrum is adequately fitted by a straight line of the form $|M|^2 \propto 1 + \alpha_\tau (M_k Q/m_\pi^2)$ Y with $\alpha_\tau = 0.126 \pm 0.008$. The spectrum of the difference of like-pion energies is found to be adequately fitted by a zero-slope line. No evidence for CP noninvariance is found for τ^+ decays. A significant violation of the $\Delta I = 1/2$ rule is observed for $K^+ \to 3\pi$ decays. Comparison with several theoretical models for $K \to 3\pi$ decays shows fair agreement between experiment and theory. (Disser. Abstr.)

Strong (Baryon-Induced)

20070 (BNL-14423) BARYON SPECTROSCOPY. Samios, N. P. (Brookhaven National Lab., Upton, N. Y.). [1969]. 33p. (CONF-700107-2). Dep. CFSTI.

From Conference on Fundamental Interactions at High Energy, Coral Gables, Fla.

This review of the baryon mass spectrum covers a discussion of the systematics of baryon states with well-known spin-parities and decay ratios, a brief description of some new results concerning several low-mass N and Σ resonances, and a review of the $Z^*(I = 0,1; Y = 2)$ situation. (J.F.P.)

20071 (IS-T-354) HYPERON-ANTIHYPERON PRODUCTION IN $\bar{p}p$ INTERACTIONS AT 2.4 AND 2.9 GeV/c. Schalk, Terry LeRoy (Ames Lab., Iowa). Nov. 1969. Contract W-7405-eng-82. 63p. Dep. CFSTI.

Thesis.

The results of a study of hyperon-antihyperon production in 2.4 and 2.9 GeV/c antiproton proton interactions are presented. The experiment had a sensitivity of 2.2 events/μ barn. Three examples of $\Xi^- \bar{\Xi}^-$ production at 2.9 GeV/c were observed. The $\Lambda\bar{\Lambda}$ and $\Lambda\bar{\Sigma}^0$ + c.c. final states were observed to be highly peripheral, indicating a t-channel exchange dominance. However, a prediction for the differential cross section from a one meson exchange model with absorption, done for a slightly higher moments (3.0 GeV/c), is not as sharply peaked as the data. The 3-body final states are produced peripherally only when the reaction is consistent with t-channel exchange of a known particle, and then only weakly. There is evidence for some Σ(1385), Λ(1404) and Λ(1520) production in these 3-body final states, however, the statistics are very limited. (auth)

20072 OBSERVATION OF ρ–ω INTERFERENCE IN ANTIPROTON ANNIHILATIONS. Allison, W. W. M.; Cooper, W. A.; Fields, T.; Rhines, D. S. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 24: 618-22(16 Mar 1970).

Evidence for structure near the ω^0 mass in the $(\pi^+\pi^-)$ mass spectrum from the reaction $\bar{p}p \to 2\pi^+2\pi^-$, at incident momenta from 1.26 to 1.65 GeV/c, is presented. This structure is interpreted as arising from ρ–ω interference in the 2π decay mode, with a statistical significance of about 3.5 standard deviations. The effect can be well fitted by a partial width $\Gamma(\omega \to 2\pi)$ in the range 0.18 to 5.3 MeV (95% confidence level). Alternatively, if $\Gamma(\omega \to 2\pi)$ is taken from e^+e^- colliding-beam results, the data can be used to study both the relative phase and coherence of ρ and ω production in $\bar{p}p$ annihilation. (auth)

20073 NEW MEASUREMENTS OF ANGULAR DEPENDENCE OF DEPOLARIZATION PARAMETER IN pp SCATTERING AT 635 MeV. Zul'karneev, R. Ya.; Nadezhdin, V. S.; Satarov, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 178-83(1970). (In Russian).

New measurements of the depolarization parameter in pp scattering at 635 MeV in a wide angle interval and with higher statistical accuracy, are made. The results obtained are compared with the experimental results of others, with predictions of the phase-shift analysis, and with the theory based on M(12) and $SU(12)_{\frac{1}{2}}$ symmetries. (auth)

20074 INTERACTION OF NUCLEONS AND HEAVY NUCLEI OF COSMIC RAYS WITH EMULSION NUCLEI OUTSIDE THE ATMOSPHERE. Alekseeva, K. I. (Moscow State Univ.). Yadern. Fiz.; 11: 184-91(1970). (In Russian).

There are 15 jets of particles with large multiplicity produced by nucleons and heavy nuclei of cosmic rays with $Z \geq 2$ analyzed. Angular parameters of all the grey and relativistic traces are measured and the nature of the slowest particles is determined. The energy of primary particles is estimated from angular distributions to be from 1.2 $(10)^{10}$ up to 2.5 $(10)^{13}$ eV/nucleon. Preliminary results obtained do not contradict the assumption that the streams of particles from total fragmentation in the collision of heavy nuclei result from superposition of several independent elementary interactions of fragmentation nucleons with those of the nucleon-target, and jets of particles with large multiplicity from nucleons result from superposition of several independent successive elementary interactions of primary nucleon with nucleons of the nucleus target. (auth)

20075 DIFFERENTIAL CROSS SECTION FOR NEUTRON–PROTON SCATTERING AT 14.1 MeV. Tanaka, Mitsuyoshi; Koori, Norihiko; Shirato, Shoji (St. Paul's Univ., Tokyo). J. Phys. Soc. Jap.; 28: 11-15(Jan 1970).

The n-p differential cross sections at 14.1 MeV were measured with a counter telescope at 8 angles in the range from 172.0 to 52.5° in the center-of-mass system. At least squares fit of the data gives the center-of-mass differential cross section: $\sigma(\Theta_n) = 52.9\ (1 - 0.0639 \cos \Theta_n + 0.0288 \cos^2 \Theta_n)$ mb/sr, which is clearly asymmetric about 90°. The ratio of the cross sections at 180 and 90° is 1.093 ± 0.022, and the total cross section is 671 ± 10 mb. The results are in good agreement with the theoretical results based on the one-pion-exchange potentials. (auth)

Strong (Meson-Induced)

Refer also to abstract 20159.

20076 (ITF-69-89) SHOWER PRODUCTION RESCATTERING AND INCREASE OF TOTAL CROSS SECTIONS AT $E \to \infty$. Lendel, A. I.; Ter-Martirosyan, K. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 12p. (In Russian). (CONF-691035-6). Dep. CFSTI (U. S. Sales Only).

From Conference on High Energy Physics and Theory of Elementary Particles, Kiev, USSR.

The data on the total cross sections obtained at the Serpukhow accelerator are discussed. It is shown that the good agreement with the experiment can be obtained in frame of the complex momentum theory if the effect of the showers production at rescattering is taken into account. The theory leads to very large values of $\sigma_\infty = \sigma_{tot}$ $(E \to \infty)$, by 10-20 mb larger then σ_{tot} at 40 GeV. (auth)

20077 (TID–25360) K^- ABSORPTION ON NEON. Tucker, Lee M. Jr. (Tennessee Univ., Knoxville). Aug 1969. 84p. Dep. CFSTI.

Thesis.

Results of a bubble chamber study of K^- meson interactions with neon nuclei are presented. The exposure was obtained in the Brookhaven National Laboratory 30-inch bubble chamber filled with a 24 mole per cent mixture of neon in hydrogen. The general systematics of K^- neon interactions are discussed and compared with results obtained in experiments with other nuclei. In particular, results on Λ^0 trapping (hyperfragment formation), single and multinucleon absorption rates, and the Σ-Λ conversion process are discussed. (auth)

20078 STRANGE-PARTICLE PRODUCTION IN 25 GeV/c π^-–p INTERACTIONS. Waters, James Wayne. Madison, Wis.; Univ. of Wisconsin (1969). 274p.

Thesis.

A study was undertaken of events having two visible decays of strange particles produced in interactions of 25 GeV/c π^- mesons with protons in the Brookhaven 80" hydrogen bubble chamber. Various cross sections were measured, in particular: $\delta_{K^0_1 K^0_1 + \text{pions}} = 163 \pm 14\ \mu b$, $\delta_{K^0_1 \Lambda(\Sigma^0) + \text{pions}} = 200 \pm 17\ \mu b$, $\delta_{K^0_1 \Sigma_\pm + \text{pions}} = 79 \pm 11\ \mu b$, $\delta\ \Xi = 20 \pm 4\ \mu b$, and $\delta_{\gamma\gamma} = 25 \pm 6\ \mu b$. The total cross section for production of two strange particles is estimated to be 4.0 ± .3 mb. Various features of strange particle production were examined. Such production is highly multiple, with average multiplicity of all secondaries ≈ 7–8. The two-body mass spectra from all final states are in remarkable qualitative agreement with those obtained at lower energies in low multiplicity final states. In particular strong threshold enhancement of the $K^0_1 K^0_1$ spectrum is seen, which does not appear to be $S^*(1068)$. A noticeable characteristic of these events is the production of numerous mesons slow in the center of mass. Hyperons are emitted preferentially backward in the center of mass with about 25% emitted forward. No evidence for two "fireball" production can be given, although the possibility of such production cannot be excluded. The values of the average transverse momentum, $\bar{p}_T$, for various particles were obtained. These are found to increase with the mass of the particles, but particles of the same mass can have different values. Relevance of the data to three different types of models is discussed: to statistical, multiperipheral, and thermodynamic models. (Diss. Abstr.)

20079 ELASTIC SCATTERING OF NEGATIVE PIONS FROM DEUTERONS AT 2.01, 3.77, AND 5.53 GeV/c. Rhoades, Terry Glenn. Minneapolis; Univ. of Minnesota (1969). 87p.

Thesis.

Measurements were made of the differential cross section for elastically scattering negative pions from deuterons in the 4-momentum transfer squared region, $0.24 \leq |t| \leq 1.3$, at 2.01, 3.77, and 5.53 Gev/c. The results are compared to Glauber multiple scattering theory calculations. Elastic events were detected in a double-arm spectrometer consisting of two bending magnets and three scintillation counter arrays. Possible elastic deuteron events were encoded and stored in a multichannel analyzer. Multiple scattering theory is reviewed including spin effects, the deuteron D state, double charge exchange, and the high energy limit. The data are found to be in good agreement with the Glauber model and with lower energy phase shift analyses. The data do not support Regge pole dominance at these energies. (Diss. Abstr.)

20080 CHARGE-EXCHANGE SCATTERING OF NEGATIVE PIONS ON PROTONS AT HIGH MOMENTUM TRANSFER. Petraske, Eric William. Minneapolis; Univ. of Minnesota (1969). 49p.

Thesis.

An experiment measuring the differential cross section of the reaction $\pi^- p \to n\pi^0$ at incident beam momenta of 2,3,4,5, and 6 Gev/c, using optical spark chambers, is reported. The data are compared with predictions from a Reggeized baryon exchange model of the process. (Diss. Abstr.)

20081 WEAK DECAY PARAMETERS OF THE Ξ^- HYPERON. Humphrey, John William. St. Louis; Univ. of Washington (1969). 147p.

Thesis.

The decay parameters and polarization of the Ξ^- hyperon produced in $K^- p$ interactions were measured at the laboratory momentum of 1.8 GeV/c. This is the first high statistics study made of the Ξ^- hyperon which used the spark chamber-counter technique. Our experiment yielded $\alpha(\Xi^-) = -.383 \pm .065$ and a preferred solution for $\phi(\Xi^-) = -26° \pm 30°$ and $P = +.19 \pm .09$. (Diss. Abstr.)

20082 A STUDY OF BARYON RESONANCES OBSERVED IN THE TWO CHARGED PARTICLE FINAL STATES FROM 2.36 GeV/C pi-P INTERACTIONS. Wilson, John Richard Jr. Boulder, Colo.; Univ. of Colorado (1968). 138p.

Thesis.

A study is presented of the baryon isobars formed in 24,000 events obtained when negative pions of momentum 2.36 GeV/c were incident on a 72 inch hydrogen bubble chamber. The purpose was to derive cross sections for the processes, and to attempt to discover the mechanisms of production and decay. Isobars were observed in three states, corresponding to the processes $\Delta^+_\chi(1236) \to p\pi^0$, $\Delta^0_\chi(1236) \to n\pi^+$; $\Delta^0_\chi(1236) \to p\pi^-$; $\Delta^-_\chi(1236) \to n\pi^-$. The Δ^+ state is formed in the presence of high background, apparently by ρ exchange. A new method of extracting the signal from the background is presented. Using this signal extraction method, the decay ratio of Δ^+ into proton and neutron channels agrees roughly with estimates from isotopic spin conservation in the decay process. The predicted ratio is 2 for the ratio $p\pi^0/n\pi^+$ and the observed ratio is ~2.2. The extraction process is not able to give decay distributions for this state. In both the Δ^0 and Δ^- states, a significant backward peaking is observed in the resonance production angle distribution. Arguments are presented to show that these backward events are the only true Δ^0, Δ^- events formed, and that what was previously thought to be Δ production by T = 2 exchange is really contamination of the signal by the ρ^0 meson. The behavior of the backward peaking Δ's is examined, and thought to be indicative of a baryon exchange production mechanism. Decay distributions are presented for the Δ state. Upper limits on the production cross sections are presented for all signals observed. They are respectively: Δ^+, Δ^0, Δ^-; 0.57, 0.04, 0.23 mb. An observation of a slight signal for the process $\pi^- + p \to p^0 + \Delta^0$ was made in the events with no fit, and an upper limit of 0.2 mb was derived for the cross section. A review of recent theoretical discussions of isobar formation and its effect on the ρ meson is presented. (Diss. Abstr.)

20083 MAGNETIC MOMENT OF THE Ξ^- HYPERON. Sander, Oscar Robert. St. Louis; Univ. of Washington (1969). 191p.

Thesis.

The magnetic moment of the Ξ^- hyperon was measured by observing the rotation of its asymmetric decay distribution in a high magnetic field. The Ξ^- hyperons were produced in the reaction $K^- + p \rightarrow \Xi^- + K^+$ at an incident K^- meson momentum of 1.8 BeV/c. A series of counters and optical spark chambers were used to detect each event. A sample of 1476 events yields a magnetic moment of $-0.1 \pm 2.1\ \mu_N$. A sample of 957 events yields an asymmetry parameter, αP, of -0.052 ± 0.032 in the center of mass production angle interval between 20 and 80°. (Diss. Abstr.)

20084 FURTHER RESULTS FROM THE CHAN–LOSKIEWICZ–ALLISON MODEL APPLIED TO THE $\pi p \rightarrow p5\pi$ REACTION AT 8 GeV/c. Ajduk, Z. (Univ., Warsaw); Michejda, L.; Wojcik, W. Acta Phys. Pol.; A37: 285-314(Feb 1970).

The original version of the Chan–Loskiewicz–Allison model was applied to the reaction $\pi p \rightarrow p5\pi$ at 8 GeV/c, which is about the average multiplicity at this energy. Contributions from different graphs were studied separately. A large overlap between momentum distributions of particles emitted from different vertices and graphs is observed. The resulting difficulties in experimental selection of leading particles are pointed out. The most efficient of the tested selection criteria, the one using c.m. longitudinal momenta, leads to a correct choice only in 50 to 60% of events. Distributions of subenergies s_i and of the four-momentum transfers t_i are discussed and related to the exchanged trajectories. The average subenergy for adjacent particles is found to be quite low, and equal to 0.5 $(GeV/c)^2$ for the $\pi\pi$ pairs and to 2.2 $(GeV/c)^2$ for the $p\pi$ pairs. The average $t_i' = t_i - t_{i,max}$ value is found to be -0.86 $(GeV/c)^2$. A comparison of the s_i and t_i distributions predicted by the model with the corresponding phase distributions shows, that the CLA matrix element favors always small t_i and s_i values. The strength of the latter effect and the correlation of transverse momenta of adjacent particles are shown to be related to the intercept of the exchanged trajectory. An unsuccessful attempt to describe pions of different charges is discussed. Predicted distributions of the c.m. opening angles for $\pi\pi$ pairs in different charge combinations are in sharp disagreement with the experimental data. (auth)

20085 CROSS SECTIONS FOR FAST PARTICLES AND ATOMIC NUCLEI. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna, USSR). Fortschr. Phys.; 17: 683-725(1969).

Presently available experimental data on the total cross sections and on the cross sections for the elastic and inelastic scattering of nucleons, antinucleons, π- and K-mesons by atomic nuclei at energies higher than 50 MeV are summarized. The nucleus-nucleus cross sections for kinetic energies higher than 50 MeV/nucl. are also given. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstracts 19597, 19598, 20027, 20053, and 20456.

General

Refer also to abstracts 20222 and 20245.

20086 (UJV-2312-F) MUTUAL TRANSFORMATIONS OF THE PARTICLES. Vymazal, M. (Cekoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [1968]. 10p. (In Czech). Dep. CFSTI (U. S. Sales Only).

An attempt is made to formulate and solve the problem of the mutual transformations of the particles. Any notions like space and time are avoided, and a single self-interacting beginning called energy is assumed. Particle decays and scattering processes are considered. (J.F.P.)

20087 THEORETICAL IDEAS ON HIGH-ENERGY COLLISIONS. Lee, Benjamin W. (State Univ. of New York, Stony Brook). Comments Nucl. Particle Phys.; 3: 198-200(Nov-Dec 1969). (CONF-690928-6).

From 3rd International Conference on High Energy Reactions, Stony Brook, N. Y.

A review of some research on high-energy particle interactions is presented. The operator version of the droplet model, the longitudinal momentum distribution of partons in a hadron, pionization at infinite energy, higher-order diagrams in scalar–vector theory, and multiperipheral diagrams are discussed. (J.F.P.)

20088 LORENTZ COVARIANT WAVE FUNCTIONS AND EQUATIONS FOR ELEMENTARY SYSTEMS. Fonda, Luciano; Ghirardi, Gian Carlo (Univ. of Cincinnati. Univ., Trieste, Italy). Fortschr. Phys.; 17: 727-63(1969).

A detailed and unified description is given of the procedures which must be followed for all cases of physical interest to go from the wave functions carrying an irreducible representation of the restricted Poincaré group, to objects having a manifestly covariant behavior. As well known, for instance for the case of spin-$\frac{1}{2}$ massive particles, this amounts to performing the inverse of a Foldy-Wouthuysen transformation. Before coming to the main subject, the construction of the irreducible representations of the restricted and extended Poincaré group is reviewed. Particular emphasis is given to the physical meaning of the representations and of the invariants which characterize them. After this, manifestly covariant quantities are derived from the wave functions of the irreducible representations of the restricted group for spin-0, -$\frac{1}{2}$, and -1, massive and massless elementary systems. The corresponding relativistically invariant equations, i.e., the Klein-Gordon, Dirac, Proca, Weyl and Maxwell equations are then derived. The transformations properties under the transformations of the extended group are also extensively discussed. (auth)

20089 THE ELECTRON REST MASS AS A UNIVERSAL MASS CONSTANT FOR NUCLEI AND ELEMENTARY PARTICLES. Witmer, E. E. (Univ. of Pennsylvania, Philadelphia). Scientia (Valparaiso, Chile); 104: 435-52(1969).

It is shown that the electron rest mass is the most significant and appropriate unit of mass for nuclei and probably for elementary particles also. It follows that if this is true then the electron rest mass is another universal constant of microscopic physics like e, h, and c. This conclusion is based on an extensive and thorough study of nuclear masses, nuclear excitation energies, and other nuclear mass and energy differences, and also the masses of elementary particles. (J.F.P.)

20090 COMPOSITE PARTICLE IN THE LEE MODEL. PROBLEM OF EQUIVALENCE IN THE (1,1) SECTOR. Maltret, Jean-Louis (UER, Paris). Compt. Rend., Ser. A; 269: 934-6(12 Nov 1969). (In French).

The case is studied in which the Lee model is given and in which characteristics of the composite model are investigated in it. This corresponds physically to the case in which the V particle becomes composite. (J.F.P.)

20091 LEE MODEL AS A Z LIMIT. Nagy, K. L. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 27: 253-60(1969).

Limits are investigated in a generalized Lee model without cut off which reproduce the elementary + composite particle case found in the original model. (auth)

Electromagnetic

Refer also to abstract 20024.

20092 (DESY-70/2). THE TOTAL PAIR PRODUCTION CROSS-SECTION IN HYDROGEN AND HELIUM. PART I. THE INTEGRATION OF THE JOST, LUTTINGER, AND SLOTNICK FORMULA FOR σ_{+-}. Knasel, T. M. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1970. 10p. Dep. CFSTI (U. S. Sales Only).

The total pair production cross section is evaluated using the formula of Jost, Luttinger, and Slotnick, for the elements hydrogen and helium. The accuracy of the work is 0.1%. (auth)

20093 (DESY-70/3) THE TOTAL PAIR PRODUCTION CROSS SECTION IN HYDROGEN AND HELIUM. PART II. CORRECTION TO THE JLS VALUE FOR σ_{+-}. Knasel, T. M. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1970. 15p. Dep. CFSTI (U. S. Sales Only).

A comparison of the Jost, Luttinger and Slotnick formula for the total pair production cross section to more recent theoretical work by Maximon, (for total coherent pair production), and by Mork (for total incoherent pair production) is presented. If one neglects the effect of atomic screening then the coherent and incoherent cross sections will be identical except for small corrections important only at low photon energies. The result of the comparison shows that the Jost, Luttinger and Slotnick formula (for coherent production) agrees with the formula of Maximon to better than 1 part per 1000 above 5 MeV. A very simple approximate formula for the total coherent (unscreened) pair production cross section is given. Finally a comparison of the difference between the Mork calculation for the unscreened incoherent cross section with the JLS formula gives the correction term that must be applied to the JLS formula in the incoherent case (called the retardation correction). The addition of screening correction and the retardation correction to the JLS formula then gives the most precise value for the total pair production. Comparison with recent experimental data shows good agreement. (auth)

20094 (INP-687) ROLE OF COULOMB INTERACTIONS IN ELASTIC AND ALMOST ELASTIC SCATTERING OF HADRONS FROM NUCLEI. Czyz, W.; Lesniak, L.; Wolek, H. (Institute of Nuclear Physics, Krakow (Poland)). Nov 1969. 73p. Dep. CFSTI (U. S. Sales Only).

An analysis of the role of Coulomb interactions in the high energy nuclear scattering processes without meson production is given. The high energy scattering model of elastic and nuclear inelastic sum rules scattering is tested on the available experimental material. Special attention is paid to the problem of extracting from the hadron-nucleus cross-sections the real parts of the hadron-nucleon elastic scattering amplitudes. (auth)

20095 (ITF-69-87) PHOTOPRODUCTION OF THE NEUTRAL VECTOR MESONS ON THE LIGHT NUCLEI. Akhiezer, A. I.; Rekalo, M. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 12p. (In Russian). (CONF-691035-2). Dep. CFSTI (U. S. Sales Only).

From Conference on High Energy Physics and Theory of Elementary Particles, Kiev, USSR.

Coherent photoproduction of the neutral vector mesons on the nuclei D, ^{3}He, and ^{3}H is discussed in terms of the Regge-pole and quark models. The experimental value of the ratio of ρ^0-photoproduction cross sections on the deuteron and proton is explained only in the Regge-pole model. From the models mentioned above, it is predicted that the ratios of ω-photoproduction cross sections on the nuclei D, ^{3}He, and ^{3}H, and the ω-photoproduction cross section on the proton should be essentially less than the ratios, predicted for the straight diffraction ω-production. (auth)

20096 (ORNL-TM-2868) APPROXIMATE DENSITY-EFFECT CORRECTION FOR THE IONIZATION LOSS OF CHARGED PARTICLES. Armstrong, T. W.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). 12 Jan 1970. Contract W-7405-eng-26. 11p. Dep. CFSTI.

An approximate density-effect correction for determining the stopping power and range of high-energy charged particles is discussed and evaluated. For a variety of materials and all particle energies, use of the approximate density-effect correction, which can be easily computed for both elements and compounds, overestimates the stopping power by $\lesssim$6% and underestimates the range by $\lesssim$4%. This error should be acceptable in many practical problems that involve materials for which the correct density effect has not been evaluated. (auth)

20097 (ORNL-tr-2280) HIGH-ENERGY INTERACTIONS OF γ-QUANTA WITH NUCLEI. Gudima, K. K.; Il'inov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Rimshaw (Oak Ridge National Lab., Tenn.), from Report JINR-P2-4808. 8p. Dep. CFSTI.

This article was previously abstracted from the original language and appeared in NSA as 24: 15791. (C.E.S.)

20098 EFFECT OF FORM FACTOR F_π IN THE ELECTROFORMATION OF π^+-MESONS AT HIGH ENERGIES. Omelaenko, A. S. (Technical Physics Inst., Kharkov). Ukr. Fiz. Zh.; 14: 1575-8(1969). (In Russian).

The most exact information on the electromagnetic form factor of the π^+-meson was obtained by studying the reaction $e + p \rightarrow e' + n + \pi^+$ with coincidence detection of the scattered electron and π^+-meson. With the π^+-meson being emitted in the forward direction, the cross section depends most strongly on the form factor. With the use of a formula analogous to one used in describing the cross section for the photoproduction of charged pions in the forward direction, it becomes possible to calculate and plot the cross section of π-mesons as a function of the square of the invariant 4-momentum (λ^2) at energies E_γ of 3.4, 5 and 8 GeV with $E_\gamma = (W^2 - M^2)$ 2M. Here W is the total particle energy and M is the mass of the nucleon. The cross section increases with increasing value of λ^2, attains a maximum at $\lambda^2 = \lambda^2_{max}$, and then decreases. The effect of the form factor F_π is most significant at $\lambda^2 = \lambda^2_{max}$. With increasing value of E_γ the position of the maximum is shifted to the side of large values of λ^2. (TTT)

20099 A CALCULATION OF THE K-MESON ELECTROMAGNETIC MASS DIFFERENCE BASED ON THE VENEZIANO REPRESENTATION. Scott, David Morris. Columbus, Ohio; Ohio State Univ. (1969). 41p.

Thesis.

An expression for the isovector part of the electromagnetic mass shift of the K mesons is derived from the difference of the first order (in the fine structure constant) electromagnetic self-energies of the positive and neutral kaons. Vector meson dominance is used to relate this part of the mass shift to strong interaction processes. A simplified Veneziano representation (including only one Regge trajectory in each channel) is written for these strong interaction processes. The results are presented in terms of a cut-off on the four momentum carried by the virtual photon producing the first order mass shift. A relatively low cut-off value of about 3 BeV is required to yield the experimental mass difference. (Diss. Abstr.)

20100 PHENOMENOLOGICAL ANALYSIS OF INELASTIC NUCLEON FORM FACTORS. Nauenberg, Michael (Univ. of California, Santa Cruz). Phys. Rev. Lett.; 24: 625-8(16 Mar 1970).

A phenomenological method to analyze the experimental data on inelastic nucleon form factors is discussed and applied to the recently published electron-proton scattering data. Theoretical speculations on these form factors are then confronted with the results of this analysis. (auth)

20101 ELECTROMAGNETIC INTERACTIONS WITH AN ARBITRARY LOOSELY BOUND SYSTEM. Krajcik, Richard A.; Foldy, Leslie L. (Case Western Reserve Univ., Cleveland). Phys. Rev. Lett.; 24: 545-8(9 Mar 1970).

An electromagnetic interaction Hamiltonian is presented for an arbitrary N-particle system with any mass, charge, spin, and magnetic moment which is consistent with the low-energy theorem for Compton scattering and the Drell-Hearn-Gerasimov sum rule to order $(\text{mass})^{-2}$. It is related to the sum of individual Foldy-Wouthuysen interactions by a unitary transformation. (auth)

20102 ELECTRON-PROTON SCATTERING BY POTENTIALS SUGGESTED BY A NEW APPROACH TO QUANTUM ELECTRODYNAMICS. Hamilton, Stephen Graham. Boston; Boston Univ. (1969). 263p.

Thesis.

A new approach to quantum electrodynamics is applied to electron-proton scattering, to first Born approximation, in the context of scattering by proton potentials which have forms suggested by the work of Sachs and Schwebel. The proton models are taken as charge distributions which incorporate the kinematical effects of three-momentum transfer but neglect the dynamical effect of the e-p interaction on the proton. Proton models considered are: δ-function, exponential, hollow exponential, gaussian, hollow gaussian, Yukawa II, and Clementel-Villi charge distributions. The range of incident electron energies is 0.1 GeV to 25.0 GeV. The best fit to experiment of all models is that given by the δ-function. δ-function model also gives a much better fit to data than Mott model. It should be noted that there are no free parameters or functional forms in δ-function model. Of all models studied the δ-function gives cross sections, in the context of the Sachs-Schwebel field theory, which most closely approach existing phenomenological descriptions. (TSS) (Diss. Abstr.)

20103 PROBABILITY LAWS IN RANDOM ELECTRODYNAMICS. Surdin, Maurice (Bordeaux Univ.). Compt. Rend., Ser. B; 270: 193-6(19 Jan 1970). (In French).

It is shown that the probability laws of an harmonic oscillator and of a free electron in a uniform magnetic field can be determined in the framework of random electrodynamics. These laws lead to the Heisenberg uncertainty principle. (auth)

20104 GAUGE INVARIANCE AND COVARIANT REGGEIZATION. Jone, H. F. (Imperial Coll. of Science and Tech., London); Scadron, M. D.; Gault, F. D. Nuovo Cim.; 66A: 424-36(21 Mar 1970).

By the use of gauge-invariant couplings the formalism of covariant Reggeization is extended to deal with processes involving photons. Particular attention is paid to pion photoproduction, where Reggeized pion and nucleon exchange are shown to connect smoothly on to the elementary exchanges both from the form of the vertex couplings and from their respective contributions to the invariant amplitudes. In the latter approach the double-pole structure of the Coulomb Born terms is correctly reproduced. Pion Compton scattering is also studied as an archetypal two-photon process: here the problem of Pomeron Reggeization is similarly resolved. The Froissart-Gribov continuation is briefly discussed, as is the forward peak in π^+ photoproduction. (auth)

20105 INVARIANT AMPLITUDES AND LOW-ENERGY THEOREMS FOR RADIATIVE DECAYS. Burlacu, L. (Univ. of Bucharest).; Raszillier, I. Nuovo Cim.; 66A: 437-48(21 Mar 1970).

Amplitudes free of kinematical singularities, zeros and constraints are given for radiative decays of bosons and fermions of arbitrary spin. They automatically lead to the higher-order low-energy theorems, which provide a way to determine the electromagnetic multipole moments of unstable particles. One has only to evaluate the (gauge invariant) pole contributions to invariant functions using kinematical-singularity- and constraint-

free vertex functions. As an example the decay $3/2 \rightarrow 1/2 + 0 + \gamma$ is considered. (auth)

20106 ANALYTICAL PROPERTIES OF PHOTON PROPAGATOR AS FUNCTION OF CHARGE AND ENERGY. Azimov, Ya. I. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 11: 206-9(1970). (In Russian).

Restrictions on analytical properties of the propagator as function of charge and energy are studied that are imposed due to the renormalization group and to the Källen–Lehmann representation. It is shown that branch points in the charge complex plane are to exist in positions depending on the energy, as well as branch points in the energy plane in positions depending on the charge. If the branch points are the thresholds of production of "resonance" states then zero in the charge plane is the condensation point for the branch points, so that the perturbational series are asymptotic expansions. (auth)

20107 ISOTOPIC RELATIONS FOR PARTICLES OF THE SAME ISOMULTIPLET. Dumbrais, O. V.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 11: 232-8(1970). (In Russian).

Weak, electromagnetic, and strong processes with production of several particles of the same isomultiplet are analyzed. Relations are obtained for the cross sections or decay probabilities with configurations related by interchanges of momenta of the particles. Supplementary relations arise in cases when some isotopic amplitudes are small as compared with others. The obtained results may be useful for testing the selection rules, as well as in investigation reactions for which direct measurement of the cross sections is difficult. (auth)

20108 POLARIZATION OF PARTICLES AND QUANTA SCATTERED BY THICK LAYERS OF MATTER. Gnedin, Yu. N.; Dolginov, A. Z.; Silant'ev, N. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 58: 706-20(Feb 1970). (In Russian).

A method is proposed for calculating the polarization and angular distribution of spin-1/2 particles and of quanta scattered by a plane layer of large optical density. The polarization of photons reflected and transmitted by an optically thick medium consisting of freely oriented particles (electrons, atoms, dust grains) is calculated on the assumption that the initial photon beam is incident at an arbitrary angle to the surface of the medium and possesses an arbitrary polarization. Analytic formulas are also obtained which describe the polarization of neutrons scattered by a plane layer of matter, the polarization being due to spin-orbit interaction with the nuclei. A numerical calculation carried out for the ^{16}O nucleus shows that the polarization may be quite large. This permits one to obtain an intense neutron beam with a polarization of several tens of percent. (auth)

20109 THE RELATIVISTIC COMPTON SCATTERING FROM A HYDROGEN-LIKE ATOM. Gorshkov, V. G.; Mikhailov, A. I.; Polikanov, V. S.; Sherman, S. G. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett.; 30A: 455-6(15 Dec 1969).

The analytical formula for the Compton effect cross section on a bound electron is obtained when the photon energy is much larger than the electron binding energy. (auth)

20110 COSMIC NEUTRINOS OF SUPERHIGH ENERGY. Berezinskii, V. S.; Zatsepin, G. T. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 11: 200-5(1970). (In Russian).

The spectrum is calculated of primary cosmic neutrinos produced in collisions of protons with relic photons. Assuming a linear increase of the neutrino-nucleon cross section with the neutrino l.s. energy up to the geometrical nucleon cross section ($\sim 3(10)^{-26}$ cm^2) the cosmic ray spectrum measured from extended air showers may well have no cut-off in the energy region $E \gtrsim 3(10)^{19}$ eV. (auth)

20111 RADIATION OF AN ELECTRON–POSITRON PAIR. Pafomov, V. E. (Lebedev Inst. of Physics, Moscow). Dokl. Akad. Nauk SSSR, 187: 552-4(July 21, 1969). (In Russian).

The results of calculating the radiation from a relativistic electron-positron pair are of interest in studying the effect of multiple particle scattering and of the earth's magnetic field on the radioemission of cascade atmospheric showers. It is assumed that the energies and lifetimes of the pair particles are the same. The intensities of emission of waves of different polarizations are averaged per unit of solid angle over all possible trajectories of the electron and positron which are caused by multiple scattering in the presence of a magnetic field. Expressions are presented for the angular distribution of the spectral energy density of emitted waves which are polarized in a plane passing through the direction of motion of the generated pair of gamma quanta, and in a perpendicular plane (in the plane of particle deflection in a magnetic field). The first term describes the sum of the radiation intensities of the electron and positron. The second term describes their interference. The presence of a magnetic field leads to an increase of intensity, and to a change in the degree of polarization of the radiation from an electron-positron pair. (TTT)

20112 SUPERCONVERGENCE OF PION FORM FACTORS AND THE STATUS OF THE KSFR RELATION. Acharya, R. (Univ., Bern). Lett. Nuovo Cim.; 4: 193-6(12 Feb 1970).

The implications of a supervergent pion form factor are investigated, starting from an off-shell dynamical equation derived from current algebra and the PCAC assumption together with a smoothness postulate. The requirement of superconvergence is found to lead to the true KSFR relation. The empirical validity of the KSFR relation suggests that the pion form factor cannot fall off arbitrarily fast for $t \rightarrow \infty$. It is concluded that the colliding-beam cross section $\sigma_{tot}(e^+e^- \rightarrow \pi^+\pi^-)$ should vanish faster than t^{-3} and at most like t^{-5} asymptotically. (L.B.S.)

20113 DEGENERACY IN THE PRESENCE OF A MAGNETIC MONOPOLE. McIntosh, Harold V.; Cisneros, Arturo (Instituto Politecnico Nacional, Mexico City). J. Math. Phys. (N. Y.); 11: 896-916(Mar 1970).

The symmetry of the force field of a magnetic monopole is comparable in its simplicity to that of the hydrogen atom or a harmonic oscillator. Both these latter systems possess a "hidden" symmetry which leads to an "accidental" degeneracy in the energy spectrum of their Schrödinger equations. Since the monopole field is derived from a vector potential which is not symmetric, but undergoes a gauge transformation under rotation, the concepts of symmetry and constants of the motion must be expressed properly in the presence of velocity-dependent forces. It is found that neither the mechanical nor the canonical angular momentum is conserved in the presence of a monopole field, but rather a total angular momentum which incorporates angular momentum resident in the magnetic field. The total angular momentum defines a cone, on whose surface the motion takes place, whatever central electrostatic potential may exist. Neither the harmonic oscillator nor the hydrogen atom retain their accidental degeneracy when the nucleus possesses a magnetic charge, but if a repulsive centrifugal potential proportional to the square of the pole strength is added, accidentally degenerate systems with a higher symmetry result. The symmetry of such a harmonic oscillator is still somewhat obscure, but the "charged Coulombic monopole" has an O(4) symmetry group generated by the total angular momentum together with a Runge vector constructed from the total angular momentum. The irreducible representations of O(4) which occur are not the n^2 representations of the hydrogen atom, but the $m \cdot n(m - n = 2\epsilon$, twice the monopole charge) representations which cannot be realized by four-dimensional spherical harmonics. The magnetic pole strength must be quantized, if admissible solutions of Schrödinger's equation are to exist, and according to Schwinger's quantization ($\epsilon = nhc/e$) if the wavefunctions are to be single valued; in any event, the ground state will be degenerate. (auth)

20114 MESON PRODUCTION BY γ RAY. Washimi, Yoshio (Osaka Univ.). Nippon Butsuri Gakkaishi; 24: 643-56(Oct 1969). (In Japanese).

The methods and the results of high energy experiments, especially of meson production by a γ-ray, made recently by using the electron synchrotron at the Institute for Nuclear Study, Univ. of Tokyo, are reviewed. For each process, a brief description is given of the behavior of the resonance state which plays the most important role. It is shown that the role of the resonance states S_{11}, P_{11}, D_{13} etc., which have isotopic spin 1/2 and low angular momentum, in each process, and the problem of isoscalar/isovector ratio of γ-ray etc. are now made clear. Lastly, some brief description is given of the problem of the meson-production by a γ-ray in a higher energy region ($E_\gamma \gtrsim 3$ GeV). (auth)

20115 SOME ASPECTS OF THE STRUCTURE OF ELEMENTARY PARTICLES AND THEIR INTERACTION. Kalashyan, R. M. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 219-29(1969). (In Russian).

A study of the classification of the elementary particles consisting of particles with integral charge was made. By assuming Kemmer's, Paule's and Dankov's theory certain values for the magnetic momenta of nucleons and hyperons were obtained. The difference in masses of p and n was calculated. The problem of estimating the constant G of superstrong interactions is analyzed, i.e., the interactions between infraparticles and hadron cores, as well as between the hadron cores themselves. (auth)

20116 RADIATIVE CORRECTIONS TO MUON DECAY WITH FINITE NEUTRETTO MASS. Csikor, F.; Nagy, K. (Roland

Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 27: 11-18(1969).

Radiative corrections to muon decay are calculated, assuming a finite neutretto mass. The corrections are shown to be free of infrared divergences even at the end point of the spectrum. (auth)

20117 ON PHOTOPRODUCTION OF NEUTRAL VECTOR MESONS AT HIGH ENERGIES. Koval, L. N.; Matinyan, S. G. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 230-2(1969). (In Russian).

The effect of photoproduction of neutral vector mesons at high energies in the Regge pole model is considered taking into account the exchange of Pomeranchuk pole and tensor reggeons (f, f^k, Ar). The Pomeranchuk pole is represented as superposition of singlet and octet, and for 2^+ nonet symmetry u (3) is assumed. Photoproduction suppression of φ-mesons conserved in asymptotic behavior is obtained. (auth)

20118 BREMSSTRAHLUNG FROM HIGH-ENERGY PROTON AND MUONS ON DIAMOND CRYSTAL. Avakyan, R. O.; Armaganyan, A. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 4: 236-8(1969). (In Russian).

The possibility for investigating the interference phenomena in high-energy proton and muon bremsstrahlung on a diamond crystal is investigated. The interference phenomena for photon bremsstrahlung appear in the keV region at a particle initial energy of about 10 GeV. (auth)

20119 MAGNETIC MOMENT OF THE Λ HYPERON. Kasumov, Yu. M. Vestn. Mosk. Univ., Ser. III, Fiz. Astron.; No. 5, 28-32 (Sep-Oct 1969). (In Russian).

Electron-positron pair annihilation into a hyperon pair ($\Lambda\bar{\Lambda}$) was calculated as a one-photon approximation. Formulas obtained were used to show that the cross sections of the $e^+e^- \to \Lambda\bar{\Lambda}$ reaction and the angular and energy dependence of the power of longitudinal polarization formed in the $\Lambda\Lambda$-hyperon pair are influenced, significantly, by the Λ-hyperon magnetic moment. (tr-auth)

Weak

20120 ALGEBRA OF CURRENTS. Maiani, L. (Istituto Superiore di Sanita, Rome); Preparata, G. Fortschr. Phys.; 17: 537-97(1969).

The most important results obtained from the algebra of currents introduced by Gell-Mann are reviewed. A detailed discussion on the derivation of sum rules (Adler-Weisberger, Cabibbo-Radicati, etc.), either with the $p \to \infty$ method and with the covariant method is included. Theorems for the emission of zero energy pions are discussed and applied to leptonic and non leptonic decays of K mesons, and to the 3π decay of the η meson. More recent developments of current algebra like the gauge fields current algebra, the Weinberg sum rules, and the applications of the Bjorken's method to weak and e.m. interactions are also discussed. (auth)

20121 "CHARGED" AND "NEUTRAL" LEPTON CURRENTS IN THE SCHEME OF WEAK INTERACTIONS INCLUDING A THIRD NEUTRINO. Romanov, Yu. I. (Inst. of Medical Radiology, Moscow). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 149-51(1969). (In Russian).

It is hypothesized that along with electron and muon neutrinos, "strange" neutrinos may occur during lepton decays of K-mesons and hyperons. In the development of the theory of a four-component Dirac neutrino it is assumed that the electron neutrino and the strange neutrino accompanying l-lepton are both left-polarized, and the mu-neutrino and strange neutrino accompanying mu-leptons are both right-polarized. It is of interest to search for reactions with the participation of these strange neutrinos, which are allowed by the law of conservation of lepton number from the four-component theory of the neutrino. In these reactions the "quasi-muon" strange neutrinos produce el-leptons, while the quasielectron strange neutrinos produce mu-leptons. Experimental data indicate that the formation of two neutral leptons from hyperon decay is suppressed to a considerable extent. It is possible that these decays are accompanied by the occurrence of massive neutral leptons (neutral mu-mesons), which possess unknown properties. The mass of a neutral muon particle may significantly exceed the mass of a charged muon. The mass of the neutral muon may be such that decay pions may exist in the same energy interval. With an increase in intensity of beams of hyperons and kaons it may be possible to detect the electron-positrons occurring during these hypothetical reactions of a neutral mu-muon. (TTT)

20122 HELICITY OF ANTINEUTRINOS EMITTED BY NUCLEI. Palathingal, J. C. (Univ. of Michigan, Ann Arbor. Univ. of Cincinnati. Madras Christian Coll.). Phys. Rev. Lett.; 24: 524-6(9 Mar 1970).

The helicity of antineutrinos emitted in nuclear transitions was measured by determining the circular polarization of gamma rays emitted by a gaseous source of ^{203}Hg and resonantly scattered by ^{203}Tl nuclei. The antineutrinos and electrons preceding these gamma rays are known to travel approximately opposite to the gamma quanta. The helicity of neutrinos emitted following electron capture was remeasured using the same apparatus. (auth)

20123 NEUTRETTO MASS AND THE RADIATIVE CORRECTIONS TO THE MUON DECAY. Matsson, L.; Peressutti, G. (Inst. of Theoretical Physics, Goteborg). Lett. Nuovo Cim.; 3: 57-9(8 Jan 1970).

The effect of a nonzero neutretto mass on the energy spectrum of electrons in muon decay, expressed as $\Gamma(E_e, m_\nu)$ (defined as the ratio of the energy spectrum for $m_\nu \neq 0$ to that for $m_\nu = 0$), is studied taking into account radiative corrections. It is shown that the infrared contribution gives a negligible correction to the function $\Gamma(E_e, m_\nu)$ when properly treated by summing up the complete infrared series. The result obtained for the case of muon decay can be extended to any reaction of the type $A \to B + C + \nu$ with a relativistic charged lepton in the final state. (L.B.S.)

20124 FORMAL SCATTERING TREATMENT OF THE NEUTRAL-K MESON SYSTEM. Horwitz, L. P.; Marchand, J.-P. (Univ. of Denver). Helv. Phys. Acta; 42: 1039-53(30 Dec 1969).

Resonance and decay phenomena associated with the neutral K mesons are discussed in the context of a modified formal scattering system. The master equation for the time evolution of the K mesons under weak interaction is obtained and the resonant structure of the scattering cross sections is established. Within the pole approximation the generalized Wigner–Weisskopf formalism and simple Breit–Wigner forms for the scattering resonances may be valid in the case of CP conservation. Deviations in the case of CP violation are discussed in detail for an explicitly soluble model. The regeneration problem is discussed. It is concluded that the validity of the generalized Wigner–Weisskopf formulation should properly be a subject for experimental investigation and not a basic assumption for the description of neutral K meson decay. (auth)

20125 LEADING DIVERGENCES IN WEAK INTERACTIONS, THE ALGEBRA OF COMPOUND FIELDS, AND BROKEN SCALE INVARIANCE. Gatto, R. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua). Riv. Nuovo Cim.; 1: 514-46(Oct-Dec 1969).

The discussion of leading divergences in weak interactions from the point of view of the algebra of compound fields with broken scale invariance covers lowest-order leading divergences, SU(3) × SU(3) breaking, the quark model at all orders, current algebra treatment of higher orders, and compound field algebra and leading divergences. Also treated are compound field algebra and high-energy e^+e^- annihilation, broken scale invariance, and generalized compound field algebra with physical consequences. (J.F.P.)

20126 K_{l4} AND K_{l3} FORM FACTORS IN THE VENEZIANO MODEL. Chan, F. C. P.; Chan, M. Y.; Chen, H. (Saginaw Valley Coll., University Center, Mich.). Lett. Nuovo Cim.; 3: 203-8(12 Feb 1970).

The K_{l4} and K_{l3} decay form factors are discussed in the Regge pole model of Veneziano supplemented by the PCAC hypothesis. Possible contribution from the daughters of the relevant $K-K_A$ trajectory is included. The unknown parameters in the form factors are not evaluated; results are obtained for the form factors corresponding to various points in the analytic domain. (L.B.S.)

20127 CABIBBO ANGLE AND $SU_2 \times SU_2$ BREAKING EFFECT ON $K^+ \to \pi^+ + \pi^0$. Nakagawa, K. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples). Lett. Nuovo Cim.; 3: 121-3(22 Jan 1970).

It is pointed out that when the Cabibbo angle is related to the finite pion mass, the SU(2) × SU(2) symmetry-breaking term, which appears in the hadron energy density (H) as a result of the Cabibbo rotation, seems to show rather large violation of the isotopic-spin invariance for finite pion mass. An attempt is made to overcome this difficulty by introducing a small deviation of the constant appearing in H, and, instead of finding the effect of Cabibbo rotation in the finite pion mass, by searching for the contribution of SU(2) × SU(2) symmetry breaking, resulting from Cabibbo rotation, in the weak decay $K^+ \to \pi^+ + \pi^0$. It is noted that the Cabibbo angle and SU(2) × SU(2) breaking can be shown to have a common origin more directly through the weak decay in which isotopic-spin violation plays an important role. (L.B.S.)

20128 GAUGE PRINCIPLE IN BETA-DECAY. Chen, Taun Wu (New Mexico State Univ., Las Cruces). Lett. Nuovo Cim.; 3: 105-7(22 Jan 1970).

The beta decay of charged spin-½ hadrons is considered, and it is shown that the current–current interactions generated by two principles of gauge transformations automatically imply the effective weak-interaction propagators of intermediate bosons which fall off as P^{-2} at high momentum. (L.B.S.)

20129 RESOURCE LETTER NEU-1 HISTORY OF THE NEUTRINO. Lederman, Leon M. (Columbia Univ., New York). Amer. J. Phys.; 38: 129-36(Feb 1970).

The history of the neutrino covers continuous beta ray distributions and the Pauli–Fermi conjecture and theory, mesons and the universal Fermi interaction, the Reines and Cowan experiment, and parity violation and two components. Also covered are the two-neutrino experiment, neutrino probes, and neutrino astronomy. (J.F.P.)

20130 A STATISTICAL METHOD FOR THE IDENTIFICATION OF LIGHT HYPERNUCLEI. Gajewski, W. (Univ., Warsaw); Vilain, P.; Wilquet, G. Acta Phys. Pol.; A37: 259-67(Feb 1970).

A statistical method is proposed for the identification of the light hypernuclei which consists in attributing a weight to every one of the various identifications of an event. The procedure is applied to the selection of a kinematically unbiased sample of $_{\Lambda}He^{5} \rightarrow \pi^{-}p\ ^{4}He$ events. Several checks are done which strongly support the validity of the procedure. (auth)

20131 RADIATION CORRECTIONS FOR CERTAIN WEAK PROCESSES WITH LEPTON PARTICIPATION. Tsvetkov, V. P. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 6, 53-60(Nov-Dec 1969). (In Russian).

Radiative corrections of the α order were calculated for weak processes of the type $\nu_{\mu} + e \rightarrow \nu_{e} + \mu$ in the laboratory system and in the center-of-mass system. Differential and total cross sections of the examined processes were obtained. Certain limitations were found in the applicability of the lower order theory of perturbations in weak interactions of the $\nu_{\mu} + e \rightarrow \nu_{e} + \mu$ type. (tr-auth)

Strong (General)

Refer also to abstract 20468.

20132 (BNL–50212) THEORIES OF STRONG INTERACTIONS AT HIGH ENERGIES. SUMMER SCHOOL IN ELEMENTARY PARTICLE PHYSICS HELD AT BROOKHAVEN NATIONAL LABORATORY, JULY 22–AUGUST 29, 1969. Peierls, Ronald F. (ed.) (Brookhaven Natinll Lab., Upton, N. Y.). Feb 1970. 481p. Dep. CFSTI.

Seven lectures are included. Separate abstracts were prepared for each lecture. (J.F.P.)

For abstracts of individual lectures see: 20133, 20134, 20152, and 20240–20243.

20133 (BNL–50212, pp 1-71) EXPERIMENTAL TOPICS IN HIGH ENERGY INTERACTIONS. White, D. Hywel (Cornell Univ., Ithaca).

The topics in high-energy interactions which are discussed cover total cross sections, forward elastic scattering, backward elastic scattering, two-body inelastic processes, and multiparticle production. Hadron interactions with hadrons are considered. (J.F.P.)

20134 (BNL–50212, pp 287-383) MULTIPERIPHERAL DYNAMICS. Chew, Geoffrey F. (California Univ., Berkeley).

A review of multiperipheral dynamics is presented in which the central unifying theme is the bootstrap concept. Relations among many models especially the multiperipheral model are considered. The framework of the S-matrix theory is used. A partial bootstrap is discussed limited to hadrons and based on the assumption that the hadrons by themselves are selfconsistent. (J.F.P.)

20135 (COO–264–530) STATISTICAL APPROACH TO THE VENEZIANO MODEL. Chang, L. N.; Freund, P. G. O.; Nambu, Y. (Chicago Univ., Ill.). Dec 1969. Contract AT(11-1)-264. 11p. (EFI–69–101). Dep. CFSTI.

A statistical approach to dual (Veneziano) dynamics is proposed. It operates with hadrons of given temperature rather than specifying in detail all hadronic quantum numbers. Heavy resonance production predictions of the statistical approach are found to agree with experiment. (auth)

20136 SOLUTION OF THE LEE MODEL IN ALL SECTORS BY DYNAMICAL ALGEBRA. Fivel, Daniel I. (Univ. of Maryland, College Park). J. Math. Phys. (N. Y.); 11: 699-705(Feb 1970).

A potential theory canonically equivalent to the Lee model in all sectors is deduced with algebraic techniques. For the Vθ sector this potential is free of disconnected graph difficulties and so is soluble in closed form. For higher sectors the problem can be reduced to Fredholm equations. (auth)

20137 STATISTICAL APPROACH TO THE VENEZIANO MODEL. Chang, L. N.; Freund, P. G. O.; Nambu, Y. (Univ. of Chicago). Phys. Rev. Lett.; 24: 628-31(16 Mar 1970).

A statistical approach to dual (Veneziano) dynamics is proposed. It operates with hadrons of given temperature rather than specifying in detail all hadronic quantum numbers. Heavy-resonance production predictions of the statistical approach are found to agree with experiment. (auth)

20138 ULTRA-HIGH-ENERGY INTERACTION. Koshiba, M. (Tokyo Univ.). Comments Nucl. Particle Phys.; 3: 161-9(Nov-Dec 1969). (CONF-690928–5).

From 3rd International Conference on High Energy Reactions, Stony Brook, N. Y.

A review of ultra-high-energy hadron interactions is presented. It is found that the N + N interaction changes properties at about 1 TeV, and the nucleon resonance aleph remains up to at least 100 TeV. A schematic prediction is given of what would be observed in inelastic collisions of 25-GeV $\bar{p}$ with 25-GeV p and 28-GeV p with 28 GeV p. (J.F.P.)

20139 A PHENOMENOLOGICAL METHOD FOR THE ANALYSIS OF THREE PARTICLE REACTIONS WITH A DOUBLE PERIPHERAL MODEL. Tuominiemi, J. K. (Univ. of Helsinki). Soc. Sci. Fenn., Comment. Phys.-Math.; 34: No. 2, 9-20(1968).

A double peripheral model is used for describing three-particle hadron collisions, and a phenomenological method for calculation of the parameters of the model is presented. The method is then applied in an analysis of some data for the reaction $K^{+}p \rightarrow K^{0}p\pi^{+}$ from an experiment at 5 GeV/c. (auth)

20140 DIFFRACTIVE INELASTIC SCATTERING AT HIGH ENERGY. Franzini, Paolo (Columbia Univ., New York). Comments Nucl. Particle Phys.; 3: 176-80(Nov-Dec 1969). (Conf-690928–4).

From 3rd International Conference on High Energy Reactions, Stony Brook, N. Y.

Diffraction scattering in particle interactions is extended to inelastic processes at high energies. Also diffractive inelastic scattering in hadron reactions with nuclei is considered. (J.F.P.)

20141 MODELS FOR HIGH-ENERGY PROCESSES. Jackson, J. D. (Univ. of California, Berkeley). Rev. Mod. Phys.; 42: 12-67(Jan 1970).

A review is given of recent developments in concepts and models for high-energy particle interactions. The sampling of recent data, Regge pole models, multiple scattering with optical models and Regge cuts, finite-energy sum rules and duality, Veneziano models, multiperipheralism, and production processes are covered. (J.F.P.)

20142 FACTORIZATION IN THE PRODUCTION OF RESONANCES HAVING SPIN. Resnick, L. (Carleton Univ., Ottawa). Amer. J. Phys.; 38: 76-9(Jan 1970).

In the production and decay of a spinless resonance or unstable particle, a factorization of the amplitude for the process is intuitively clear and is useful for phenomenological analysis. The intuitive picture in the case of a resonance having non-zero spin is less clear. It is shown under what conditions an equivalent factorization occurs in the cross section for this latter case. (auth)

20143 MINNAERT'S CONDITIONS ON THE MULTIPOLE PARAMETERS OF THE SPIN DENSITY MATRIX FOR SPIN 2. Krasznovszky, S.; Lichtwitz-Janossy, V.; Posch-Telbisz, M. KFKI (Kozp. Fiz. Kut. Intez.) Kozlem.; 18: 3-11(1970). (In Hungarian).

Some inequalities are given for the multipole parameters in the case of particles of spin 2, derived from the positivity of the density matrix ρ and from the condition Tr $\rho = 1$. (auth)

Strong (Baryon No. = 0)

Refer also to abstract 20085.

20144 (NP-18127) DETERMINATION OF THE Kπ ELASTIC CROSS SECTION BY CHEW–LOW EXTRAPOLATION. Linglin, Denis (European Organization for Nuclear Research, Geneva (Switzerland)). 27 Nov 1969. 158p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

This review of the determination of the K + π elastic cross

sections by the Chew–Low extrapolation covers the theoretical explanation, statistical methods of analysis, the results, and a comparative study of various actual methods of extrapolation. (J.F.P.)

20145 PARAMETRIZATION OF CROSSING SYMMETRIC AMPLITUDES. Roskies, Ralph Z. (Yale Univ., New Haven). Contract AT(30-1)-2726. J. Math. Phys. (N. Y.); 11: 482-6 (Feb 1970).

The crossing equations of Balachandran and Nuyts are solved to give the most general expansion of the $\pi^0-\pi^0$ amplitude consistent with crossing symmetry and in which the partial wave expansion is manifest. It is found that crossing symmetry imposes 2L + 1 constraints on the Lth partial wave if the lower waves are known. The simplest such constraint (in the units were $4m_\pi^2 = 1$) is $\int_0^1 (1-s)(3s-1)f_0(s)\,ds = 0$, where $f_0(s)$ is the s-wave $\pi^0-\pi^0$ amplitude. (auth)

20146 SIMPLE APPROACH TO UNITARIZATION IN HARD-MESON CALCULATIONS. Rockmore, Ronald (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev. Lett.; 24: 541-4(9 Mar 1970).

The hard-pion effective-range formula for the pion form factor of Brehm, Golowich, and Prasad is derived from unitarity and (vector) meson dominance assuming a real tree form factor as input. The result is generalized and applied to the π-A_1-ρ system. The suitably continued finite ρ-width form factors are used to calculate the soft π^+-π^0 mass difference when both tree form factors are unsubtracted in broken chiral symmetry ($\delta m \simeq 5.7$ MeV) and when both tree form factors are subtracted ($\delta = -\frac{1}{2}$) ($\delta m \simeq 5.2$ MeV). (auth)

20147 INTRODUCTION OF LORENTZ POLES INTO THE UNEQUAL-MASS SCATTERING AMPLITUDE. Szegoe, K.; Toth, K. (Central Research Inst. for Physics, Budapest). Nuovo Cim.; 66A: 371-400(21 Mar 1970).

A new type of kinematical decomposition of the unequal-mass scattering amplitude is suggested. Two noncommuting, nondisjunct Poincaré groups, P^+ and P^-, are introduced; both of them are subgroups of the $P_1 \otimes P_2$ direct-product group, where P_1 and P_2 are the Poincaré groups of the one-particle transformations for the first and the second particle of the two-particle states, respectively. The group P^+ is identical to the group of the two-particle Poincaré transformations. The first decomposition for the scattering amplitude is a double expansion with respect to the representations of both the P^+ and P^- groups, simultaneously. The second proposal is the partial-wave analysis not of the centre-of-mass states but of the "equal velocity" states, in which the individual particles move with the same velocity. The expansions are valid for any s and t. In the equal-mass case they give the usual Lorentz-pole decomposition at t = 0. The formalism seems to be adequate for understanding the meaning of the "spectrum generating group" in the unequal-mass case. The variables of the expansion functions are unambiguously defined by the kinematical variables, and have branch points only at the thresholds and pseudothresholds, in opposition to other approaches. (auth)

20148 ELEMENTARY CONSEQUENCES OF DUALITY AND UNITARITY, WITH APPLICATION TO THE POMERANCHUK SINGULARITY. Goldberg, H. (Northeastern Univ., Boston). Lett. Nuovo Cim.; 3: 27-30(1 Jan 1970).

The duality hypothesis which states that a combination of t-channel Regge amplitudes may be built out of S- and U-channel resonances is investigated for the case of the P-singularity. The consequences of unitarity, following an assumption of S–U (backward) duality are examined. The case of πK scattering is considered. (L.B.S.)

20149 CURRENT ALGEBRA CALCULATION OF THE $\pi\pi$, I = 0,2 SCATTERING LENGTHS. Ghika, G.; Radescu, E. E.; Visinescu, M. M. (Inst. of Atomic Physics, Bucharest). Acta Phys. Pol.; A37: 167-72(Feb 1970).

Using the Fubini–Furlan extrapolation procedure, an evaluation of the $\pi\pi$ s-wave scattering lengths is given. In calculating the off shell corrections, it is accepted that there is no appreciable $\pi\pi$ interaction and the contributions of the "Z graphs" are taken into account. (auth)

20150 VENEZIANO MODEL AND THE PION ELECTROMAGNETIC FORM FACTOR. Ghika, Gr.; Visinescu, M. (Inst. for Atomic Physics, Bucharest). Lett. Nuovo Cim.; 3: 9-12 (1 Jan 1970).

An attempt is made to connect the pion electromagnetic form factor directly to the Veneziano amplitude for $\pi\pi$ scattering by imposing elastic unitarity. The partial wave I = J = 1 is calculated from the Veneziano $\pi\pi$ amplitude and a definite procedure for unitarization is used. Finally, the corresponding integral equation for the pion electromagnetic form factor written in the elastic-unitarity approximation is solved. (L.B.S.)

20151 DUALITY AND THE QUARK MODEL FOR MESONS. Kokkedee, J. J. J. (Univ., Nijmegen, Netherlands). Lett. Nuovo Cim.; 3: 129-34(22 Jan 1970).

The consequences of the duality principle and absence of exotic resonances are discussed for the full set of meson trajectories generated by the nonrelativistic quark model. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 20084 and 20217.

20152 (BNL–50212, pp 159-247) FORMALISM AND PHENOMENOLOGY OF COMPLEX ANGULAR MOMENTUM. Huang, Kerson (Massachusetts Inst. of Tech., Cambridge).

Two-body hadron scattering in the high-energy limit is discussed under the hypothesis that it is dominated by Regge singularities. Regge poles in potential scattering, the relevance of Regge poles to relativistic scattering, relativistic scattering of spinless particles, physical consequences, Regge cuts, dynamics, and spin are discussed. Pion–nucleon scattering is considered as an example. (J.F.P.)

20153 (IS-T-355) PHENOMENOLOGICAL REGGE TRAJECTORIES IN DIRECT CHANNEL PION–PROTON ELASTIC SCATTERING. Stoessel, Edward Thomas (Ames Lab., Iowa). Nov 1969. Contract W-7405-eng-82. 77p. Dep. CFSTI.

Thesis.

An investigation of the possibility of using a direct channel Regge pole theory to describe low energy scattering data is described. The model amplitude which is derived is similar to the modified Regge representation proposed by Mukherjee but is different in two important respects: The Mukherjee representation does not apply to a process in which the particles may have spin whereas the one presented here applies to the helicity amplitudes of the general Jacob-Wick expansion. The Reggeization of a signatured helicity amplitude does not lead to a signatured model except in the spinless case. It is shown how to ensure the preservation of signature by including an appropriate part of the background integral. A preliminary numerical investigation of the pion-proton elastic scattering process is discussed and it is found that there is some likelihood of the success of a more extensive numerical study. (auth)

20154 (ITF-69-70) VECTOR DOMINANCE, CURRENT CONSERVATION AND THE REACTION $\pi N \to \rho N$ AT HIGH ENERGIES. Achasov, N. N.; Shestakov, G. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 16p. (CONF-691035-1). Dep. CFSTI (U. S. Sales Only).

From Conference on High Energy Physics and Theory of Elementary Particles, Kiev, USSR.

The pole-vector-dominance model is formulated for invariant amplitudes. It is shown that the assumption of independence of the vector meson mass, the invariant amplitudes, and the current conservation condition lead to relations among t-channel helicity amplitudes. These relations are studied for the reaction $\pi N \to \rho N$ in various Regge models. In the Regge pole model with π, ω, and A_2 exchange relations connecting the spin density matrix elements for the ρ-meson are obtained. These can be tested experimentally. For the reaction $\pi^- p \to \rho p$ at 8 GeV/c the agreement with experiment is quite satisfactory for not too small values of $|t|$. (auth)

20155 (UCRL–19361) ASPECTS OF BARYON RESONANCES. Tripp, Robert D. (California Univ., Berkeley. Lawrence Radiation Lab.). 1 Oct 1969. Contract W-7405-eng-48. 81p. (CONF-690827-1). Dep. CFSTI.

From 3rd Topical Conference on Particle Physics, Honolulu, Hawaii.

The discussion of baryon resonances covers some concepts for the analysis of these resonances in production experiments, the multiplet structure decay rates, and signs of the reaction amplitudes of better-established resonances in SU(3) symmetry. Emphasis is placed on the elaboration of the $\frac{1}{2}^-$ octet and singlet. Some recent results concerning Y^* resonances are also examined. The N^* and Ξ^* are discussed relative to their SU(3) classifications. Lastly the existence of the exotic baryon resonances are considered. (J.F.P.)

20156 GENERALIZED SUPERCONVERGENCE RELATIONS FOR KN AND $\bar{K}N$ SCATTERING. Vasavada, K. V. (Univ. of Connecticut, Storrs). Can. J. Phys.; 46: 2471-2(1 Nov. 1968).

Generalized superconvergence relations for KN and $\bar{K}N$ scattering are used to deduce parameters of the rho meson trajectory.

Results are found to be in reasonable agreement with those from previous analyses using different methods. (auth) (Canada)

20157 HIGH-ENERGY PION–NUCLEON INTERACTIONS. Walker, W. D. (Univ. of Wisconsin, Madison). Comments Nucl. Particle Phys.; 3: 181-9(Nov-Dec 1969). (CONF-690928-7).

From 3rd International Conference on High Energy Reactions, Stony Brook, N. Y.

A review of high-energy pion–nucleon interactions is presented. Diffractive dissociation is briefly discussed, and the production of hyperons and K pairs is considered. It is pointed out that one cannot sharply differentiate between various proposed theories, and that any correct theory must take into account the detailed structure of the nucleon as well as the interaction. (J.F.P.)

20158 VENI, VIDI, VICI REGGE THEORY. Fox, Geoffrey C. (Cambridge Univ., Eng.). Comments Nucl. Particle Phys.; 3: 190-7(Nov-Dec 1969). (CONF-690928-3).

From 3rd International Conference on High Energy Reactions, Stony Brook, N. Y.

Three theorems almost everywhere valid are stated without proof. These are that the cut corrections to Regge pole theory are at least as large as predicted by the absorption model, that the predictions of the absorptive-cut model are generally incorrect, and knowledge on the general properties of cuts is insufficient for meaningful phenomenology. The examples discussed are $\pi + N$ charge exchange, photoproduction, and $p + p \rightarrow p + p$ scattering. (J.F.P.)

20159 EVIDENCE FOR THE EXISTENCE OF A Z*. Kato, S. (Argonne National Lab., Ill.); Koehler, P.; Novey, T.; Yokosawa, A.; Burleson, G. Phys. Rev. Lett.; 24: 615-18(16 Mar 1970).

Results of a phase-shift analysis with and without the use of a Regge-pole model in K^+p elastic scattering from 0.86 to 1.95 GeV/c are described. Four possible solutions are obtained, all of which indicate resonantlike behavior in one partial-wave amplitude. Three of our solutions yield a $P_{\frac{1}{3}}$ partial wave with a behavior consistent with the Breit–Wigner resonance formula. The properties of such a Z* resonance are described. (auth)

20160 A MODEL FOR η PRODUCTION AND S_{11}-WAVE. Lefievre, B.; Leruste, P. (College de France, Paris). Nuovo Cim.; 66A: 349-61(21 Mar 1970).

An analysis was made of both η-pion production and π-nucleon S_{11} phase shift. In particular numerical information is obtained about the latter from the $\pi N \rightarrow \eta N$ total cross section. The extended Le Couteur-Newton formalism is used for only two channels. Experimental results are explained by a semi-strong interaction between π-N channel and η-N channel. (auth)

20161 RHO-DOMINANCE AND A NEW FAMILY OF SUM RULES FOR PION–BARYON SCATTERING. Banerjee, H. (CERN, Geneva); Mallik, S.; Dutta-Roy, D. Nuovo Cim.; 66A: 475-91 (21 Mar 1970).

A family of sum rules for the scattering of pions from spin-one-half baryon targets is presented. The derivation of the sum rules is based on the assumptions of i) unsubtracted dispersion relations for both the forward and the backward amplitudes (nonflip, flip and the A amplitudes) corresponding to unit isospin in the t-channel, and ii) rho-dominance (near direct-channel threshold) of the t-channel contributions in the dispersion relations for the backward amplitudes. In the πN sector, where a direct verification of our sum rules is possible, they are in satisfactory agreement with the available experimental data. Resonance saturation of our sum rules in the $\pi\Sigma$ sector together with the assumption of universal rho-hadron coupling yields the isovector magnetic moment of Σ in good agreement with the SU_3 prediction. As for pion-baryon coupling the sum rules in both the $\pi\Sigma$ and $\pi\Xi$ sectors are consistent with SU_3 symmetry with F/D ratio $\sim \frac{2}{3}$. Our analysis of the $\pi\Xi$ sum rules further suggests the spin-parity assignment $J^P = \frac{1}{2}^-$ for $\Xi^*(1930)$. (auth)

20162 REAL PART OF THE VECTOR-MESON–NUCLEON SCATTERING AMPLITUDE FROM A QUARK REGGE-POLE METHOD. Jackson, S. A.; Mickens, R. E. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)2098. Lett. Nuovo Cim.; 3: 1-5(1 Jan 1970).

The total cross section and phase of the forward scattering amplitude for vector-meson–nucleon scattering are calculated using the quark model and Regge theory. Results are presented for the ϕ–p and ρ^0–p interactions from 6 to 20 GeV/c. A comparison is made with results of a recent analysis of vector-meson photoproduction from nuclei. (L.B.S.)

20163 THE PION TRAJECTORY IN THE PROCESSES $\pi^+p \rightarrow \rho^0\Delta^{++}$ AND $K^+p \rightarrow K^{*0}\Delta^{++}$. Markytan, M.; Schmid, P. (Institut fuer Hochenergiephysik, Vienna). Lett. Nuovo Cim.; 3: 51-6 (8 Jan 1970).

An analysis is made of the cross sections for the $\pi^+ + p \rightarrow \rho^0 + \Delta^{++}$ and $K^+ + p \rightarrow K^{*0}(890) + \Delta^{++}$, using a combination of Wolf's OPE formula and a Regge-type propagator and energy dependence. It is concluded that the slope of the pion trajectory assumed as a linear trajectory is always less than 1 $(GeV/c)^{-2}$. (L.B.S.)

20164 HYDROGENLIKE QUARK MODEL FOR BARYONS. Leal Ferreira, J.; Leal Ferreira, P. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Lett. Nuovo Cim.; 3: 43-7(8 Jan 1970).

A quark model for baryons (considered as qqq structures) is discussed from which a mass spectrum with hydrogen-like features can be derived. (L.B.S)

20165 KINEMATIC VARIABLE FOR DESCRIBING SCATTERING AT HIGH ENERGIES. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 6, 20-3 (1969). (In Russian).

An attempt was made to show that $x(k,\theta)$ the normalized differential cross sections of forward scattering as a function of a certain combination of $\underline{k}$ and $\underline{\theta}$ impose certain limitations of the behavior of x and relates the function with the energy behavior of the partial S-amplitude. The problem was presented assuming that in the normalized amplitude $x_1(k,\theta)$ $(X = |X_1|^2)$ the $\underline{k}$ and $\underline{\theta}$ are presented in combination $\varphi(k,x)$ $(x = \cos\theta)$. Experimental data on the differential cross sections of hadron elastic scattering at high energies confirmed the assumption not only for the events of πp, Kp, but also for pp scattering. (R.V.J.)

20166 ANTIPROTON–DEUTERON INELASTIC INTERACTION IN IMPULSE APPROXIMATION. Nemirovskii, P. E.; D'yakonov, I. A. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 11: 131-9(1970). (In Russian).

Processes of inelastic disintegration induced by incident antiproton and charge exchange of antiprotons on deuterons in the energy region of the incident antiprotons about 25 to 100 MeV, are studied. Numerical calculations of inelastic disintegration cross sections and of charge exchange are performed by approximate methods. The criterion to estimate the value of the cross section of antiproton–deuteron annihilation is obtained. The cross sections of the charge exchange and annihilation in antiproton–deuteron processes are compared with corresponding cross sections of the antiproton–nucleon problem for equivalent energies. (auth)

20167 ZERO MASS PIONS. Hamilton, J. Copenhagen; NORDITA (1969). 85p. (NP-18163).

Pion–nucleon scattering with the masses of both external pion lines continued to zero is considered. Singularities, dynamical models, mass extrapolation, and subtracted S-wave dispersion relations are discussed. (J.F.P.)

20168 CROSSING RELATIONS FOR CENTER-OF-MASS- AND BREIT-SYSTEM CANONICAL AMPLITUDES. Chakrabarti, A. (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.); 11: 1085-1104(Mar 1970).

The crossing relations for the canonical amplitudes are derived starting with the case of four particles of nonzero rest mass. Results are given for both the center-of-mass- and the Breit-frame amplitudes and compare two different point of view. The definition of the "Breit system" is adapted to a unified treatment of all the three types of momentum transfer. It is shown that the Breit-frame amplitudes need no preliminary adjustments of constraints or the definition of a "generalized" amplitude in the alternative point of view. It is also shown that the usual convention about the continuation of the covariant spinor amplitudes involve, for the particles to be crossed, a rotation π of the "physical" spin about the direction of the continued momentum. The corresponding results for the helicity and the transversity amplitudes are derived as corollaries. Finally, the case of amplitudes involving zero-mass particles is discussed and some remarks are added concerning the kinematic singularities. The definition of the canonical and the transversity amplitudes are compared and some useful Lorentz-transformation formulas are collected together. The transformations connecting the center of mass and the Breit frames are parametrized in terms of the invariants. The well-known invariant amplitudes for πN scattering are used to verify the canonical formula. (auth)

20169 HADRONIC FORM FACTORS AND THE CURRENT ALGEBRA IN INFINITE MOMENTUM FRAME. Novozhilov, Yu. V.; Prokhvatilov, E. V. Vestn. Leningrad. Univ., No. 22, Fiz., Khim.; No. 4, 53-60(Nov 1968). (In Russian).

It is shown that current algebra in the one particle space with a

degenerate mass spectrum leads to nucleonic form factors which are in striking disagreement with experiment. Therefore, the only way to save such an approach is to consider the classification of resonances and their mass spectrum simultaneously. (auth)

20170 FORWARD π^-p CHARGE-EXCHANGE SCATTERING AT (2 TO 18) GeV. Minami, S. (Osaka City Univ.). Lett. Nuovo Cim.; 3: 124-8(22 Jan 1970).

The π^-p charge-exchange scattering at 2 to 18 GeV is studied using a new interference model proposed by Coulter et al. (Phys. Rev. Lett., 23: 106(1969)). It is shown that without employing the Veneziano model, it is possible to obtain an amplitude for meson-nucleon scattering which is free from double counting. (L.B.S.)

20171 TOWARDS A DYNAMICAL CALCULATION OF THE ROPER RESONANCE. Jacobs, D.; Lambert, F. (Vrije Univ., Brussels). Lett. Nuovo Cim.; 3: 173-5(5 Feb 1970).

The analytic continuation of the nucleon propagator in the energy plane can give rise to poles on the second Riemann sheet, which can be interpreted as corresponding to excited states of the nucleon with the same quantum number. The possibility of finding such a pole, which can be associated with the Roper resonance is investigated. (L.B.S.)

20172 CHARACTERISTIC DIFFERENCE OF pi–N AND N–N INTERACTIONS IN THE COSMIC-RAY ENERGY REGION. Kazuno, M. (Dublin Inst. for Advanced Studies). Lett. Nuovo Cim.; 3: 182-5(5 Feb 1970).

The characteristics of pion interactions and nucleon interactions are studied from the viewpoints of not only the comparison of the average values of the physical quantities but also of the correlations among these quantities for each type of interaction. The characteristic quantities considered are the multiplicity n_s, angular distribution σ, and the primary energy. The following conclusions are made: (a) the average values of n_s and σ in $\pi-N$ interactions are 10 to 20% smaller than those in the corresponding $N-N$ interactions at the same primary energy; (b) σ increases with primary energy roughly logarithmically with γ_c for both $N-N$ and $\pi-N$ interactions; and (c) σ increases with n_s at a fixed primary energy for $N-N$ interactions but this tendency is not obvious for $\pi-N$ interactions. (L.B.S.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 20094 and 20165.

20173 (ITF-69-86) ONE-PION AND DIFFRACTION COMPETITION IN NUCLEON RESONANCES PRODUCTION PROCESSES. Rekalo, M. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 12p. (In Russian). (CONF-691035-4). Dep. CFSTI (U. S. Sales Only).

From Conference on High Energy Physics and Theory of Elementary Particles, Kiev, USSR.

The influence of a one-pion mechanism on the energy dependence of total cross sections of processes $p + p \rightarrow p + N^*$ is discussed. It is shown that the one-pion contribution is small for reaction $p + p \rightarrow p + N^*(1470)$ in comparison with diffraction contribution in the region of a moderate high energies (momentum of the initial particle is less 10 BeV/c). The one-pion contribution for the reaction $p + p \rightarrow p + N^*(1518)$ equals the diffraction contribution for the moderate high energies that result in maximum for the energy dependence of the total cross section of this process. It is predicted, that the maximum must be absent in the energy dependence of the total cross sections of the production isotopic spin 1/2 resonances N^* in reactions $\pi^+ + p \rightarrow \pi^+ + N^*$, $K^+ + p \rightarrow K^+ + N^*$ at moderate high energies: the cross sections must achieve their asymptotic values smooth. (auth)

20174 (SU-1206-214) LOW ENERGY PROTON–PROTON SCATTERING WITH A SEPARABLE POTENTIAL, AND APPLICATIONS TO FINAL STATE INTERACTIONS INVOLVING TWO PROTONS. Gardinr, C. W. (Syracuse Univ., N. Y. Dept. of Physics). Sep 1969. 37p. (NYO-3399-214). Dep. CFSTI.

It is shown that a separable potential may be added to a Coulomb potential to give an exactly soluble equation. This equation is solved using some approximations which are necessary to get simple analytic formulas, and derive effective range formulas for the p-p system. Fits are compared to the data for p-p, n-n, and n-p (singlet) scattering, and it is concluded that the treatment is consistent with charge symmetry between p-p and n-n reactions, but that the n-p (singlet) has significantly different behavior. Finally, the wavefunctions derived are used to give a treatment of p-p final state interactions, which is compared with n-n and n-p final state interactions in the impulse approximation. The treatment differs from others in that all the sets of two nucleon wavefunctions involved are complete and orthogonal, since they are all solutions of Schrödinger equations (the approximation in the p-p calculations modifying the separable potential, so that the wavefunctions are still solutions of a Schrödinger equation). (auth)

20175 SCALAR MESONS AND THE N–N INTERACTION. Stagat, R. W.; Riewe, F.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev. Lett.; 24: 631-5(16 Mar 1970).

The ϵ meson, a broad isoscalar scalar resonance, is phenomenologically incorporated into our one-boson-exchange analysis to produce a realistic model of the N–N interaction involving only known mesons. (auth)

20176 HIGH ENERGY SCATTERING OF COMPOSITE PARTICLES. II. CLASSIFICATION OF MULTIPLE SCATTERING CONTRIBUTIONS. Formanek, J. (Univ., Bonn). Czech. J. Phys.; 19: 1500-9(1969).

All inequivalent multiple scattering contributions are found for the collision of two composite particles, each of them consisting of less than five elements. The cross section for high energy $\alpha-\alpha$ scattering is calculated as an example. Some properties of multiple scattering are briefly discussed. (auth)

20177 NEW MODEL FOR CALCULATION OF HIGH-ENERGY NUCLEON PENETRATION THROUGH MATTER. Turner, J. E.; Wright, H. A.; Grossen, J. H. (Oak Ridge National Lab., Tenn.). Health Phys.; 18: 80-1(Jan 1970).

A new model is considered for calculations of nuclear cascades consisting of free target nucleons distributed uniformly and at rest in the target. Using this model too large a macroscopic nuclear collision cross section is given and too few secondary nuclei per nuclear cascade (except with hydrogen) occur. Those factors are shown to offset each other by comparison of results using this model and those obtained with a detailed model reported earlier. Good correlation is reported from comparisons of the total energy absorbed, the depth distribution and the number of escaping protons, in a 30 cm soft-tissue slab. (UK)

20178 POLARIZATION EFFECTS IN pp AND $\bar{p}p$ SCATTERING AT HIGH ENERGIES. Jacob, M.; Weyers, J. (CERN, Geneva). Nuovo Cim.; 66A: 401-8(21 Mar 1970).

A simple model is developed which allows a qualitative understanding of the observed structures in the pp polarization data and leads to predictions for the $\bar{p}p$ polarization. (auth)

20179 INVESTIGATION OF TWO-REGGEON CUTS IN SCATTERING PROCESSES AT HIGH ENERGIES. Kaidalov, A. B.; Karnakov, B. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 216-31(1970). (In Russian).

Expressions for contributions from the two-reggeon cuts to the amplitudes of various two-particle processes are obtained with account of spins of the interacting particles. Conditions for the reggeized absorptive model to be applicable are discussed. A formula is given that enables one to estimate the cross sections of the processes like the double charge exchange. The contributions are calculated from moving cuts to the amplitudes of np charge exchange, pseudoscalar meson photoproduction, production of vector mesons in πN collisions at small momentum transfers. Superconvergent sum rules for the reggeon production amplitudes are considered. (auth)

20180 REGGE MULTIPLE RESCATTERING IN pp ELASTIC LARGE ANGLE SCATTERING. Boreskov, K. G.; Pirogov, Yu. F. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 11: 210-15(1970). (In Russian).

It is assumed that at high energies the large-angle scattering of hadrons proceeds through multiple small-angle rescattering. The separate scattering acts are described by the vacuum Regge pole. The corresponding series of the Regge cuts is calculated in an approximation (like that of eikonal) by means of the steepest descent method in the impact parameter plane. The asymptotic formula is obtained as a sum of contributions from the infinite set of the saddle points. The contribution from two main saddle points is in reasonable agreement with the exact computer calculations. (auth)

20181 ELASTIC PROTON–PROTON SCATTERING IN THE EIKONAL MODEL AND THE SLOPE OF THE POMERANCHUK TRAJECTORY. Kaplan, J. M.; Schiff, D. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Lett. Nuovo Cim.; 3: 19-22(1 Jan 1970).

Recent experimental data show a significant shrinking of the diffraction peak in p-p scattering at energies greater than 20 GeV/c. The minimum modifications to the hybrid model needed to account for the new data are investigated. (L.B.S.)

20182 ANGULAR DISTRIBUTIONS OF SECONDARIES PRODUCED IN HIGH ENERGY PROTON–PROTON INTERACTIONS IN HAGEDORN'S THERMODYNAMICAL MODEL. Klosinski, J. (Univ. of Lodz, Poland). Acta Phys. Pol.; A37: 251-7(Feb 1970).

Angular distributions of pions and protons produced in high energy proton–proton collisions are analyzed in terms of the Hagedorn model. They show a two-maxima structure in variables $A = \ln \tan (\theta/2)$. (auth)

20183 DEUTERON–DEUTERON ELASTIC SCATTERING IN THE GeV RANGE. Alberi, G. (Univ., Trieste, Italy); Bertocchi, L.; Bialkowski, G. Lett. Nuovo Cim.; 3: 108-12(22 Jan 1970).

Deuteron-deuteron elastic differential cross sections at 0.68 to 79 GeV/c are calculated in the Glauber multiple scattering theory including contributions from the triple- and quadrupole-scattering terms. The results are compared with experiment. (L.B.S.)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 19733 and 20235.

20184 (NYO–4076-7) RESEARCH IN THEORETICAL PHYSICS. Annual Report, April 1, 1969–March 31, 1970. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Jan 1970. Contract AT(30-1)-4076. 8p. Dep. CFSTI.

Research is reported on the combination of analyticity and symmetry properties into a unified scheme for the understanding of hadron interactions. A list of publications issued during this period is appended. (J.F.P.)

20185 ON THE DECOMPOSITION OF A UNITARY REPRESENTATION OF THE (1 + 4) DE SITTER GROUP WITH RESPECT TO REPRESENTATIONS OF THE LORENTZ GROUP. Stroem, Staffan (Chalmers Tekniska Hogskola, Goteborg). Ark. Fys.; 40: 1-33 (1969).

A unitary irreducible representation of the covering group of the (1 + 4) de Sitter group, belonging to the principal continuous series, is decomposed with respect to unitary representations of a non-compact subgroup. The latter is isomorphic to the covering group of the Lorentz group. The general features of the decomposition are established by means of a global method. Possible applications are indicated. From the general formulas given, more explicit results can easily be derived, such as decomposition formulas for matrix elements. An example of this kind is treated in some detail. The covering group of the (1 + 4) de Sitter group is described in terms of a "spinor group" of 2×2 quaternionic matrices in a formalism which is similar to the SL(2,c)-description of the covering group of the Lorentz group. (auth)

20186 RELATION BETWEEN THE O(4) AND O(3,1) PARTIAL-WAVE EXPANSIONS. Akyeampong, D. A.; Boyce, J. F.; Rashid, M. A. (International Centre for Theoretical Physics, Trieste, Italy). J. Math. Phys. (N. Y.); 11: 706-14(Feb 1970).

The $t = 0$, O(3,1), expansion of a square-integrable equal-mass-scattering amplitude is considered. By assuming the existence of an unsubtracted dispersion relation, it is explicitly shown to continue to an O(4) expansion for $(m_1 - m_2)^2 \leq s \leq (m_1 + m_2)^2$. The continuation requires the introduction of O(3,1) signature; nonsense-channel terms arise; however, their complete sum is zero. (auth)

20187 RECENT PROGRESS TOWARD A THEORY OF TENSOR OPERATORS IN THE UNITARY GROUPS. Louck, James D. (Los Alamos Scientific Lab., N. Mex.). Amer. J. Phys.; 38: 3-42(Jan 1970).

The theory of tensor operators in the unitary groups is developed in a form which parallels the familiar Racah–Wigner angular momentum calculus. The presentation is principally an attempt to synthesize published results into a comprehensive whole. (auth)

20188 ARBITRARY 3n–j SYMBOLS FOR SU(2). Shapiro, Joel (Univ. of California, Berkeley). Comput. Phys. Commun.; 1: 207-15(Jan 1970).

The discussion of the program for arbitrary 3n–j symbols for SU(2) covers the structure of the program, the use of CDC extended FORTRAN, and various limitations and tests. (J.F.P.)

20189 RELATIVISTIC QUANTAL OSCILLATOR. Lipis, P. O. (International Centre for Theoretical Physics, Trieste, Italy). Amer. J. Phys.; 38: 85-7(Jan 1970).

The Klein–Gordon equation is solved approximately for the three-dimensional harmonic-oscillator potential. Mathematically, the radial equation has the form of the nonrelativistic equation with an r^4 anharmonic term added. The calculation is carried to lowest relativistic order and an energy spectrum is obtained with the following intuitively-expected features: the level spacing decreases with increasing energy and the l degeneracy is broken. The same result is also obtained by putting the relativistic kinetic energy into the Schrödinger equation and expanding in p^2. (auth)

20190 TWO-TRIPLET MODEL OF "DIRECT" MUON PRODUCTION. Ladanyi, K. (Research Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 27: 549-58 (1969).

A particular two-triplet model of "direct" lepton production is suggested by assuming that both leptons and hadrons belong to representations of the six-dimensional rotation group SO_6. (auth)

20191 CLEBSCH–GORDAN COEFFICIENTS FOR THE COUPLING OF SL(2,C) PRINCIPAL-SERIES REPRESENTATIONS. Anderson, R. L.; Raczka, R.; Rashid, M. A.; Winternitz, P. (International Atomic Energy Agency, Trieste, Italy). J. Math. Phys. (N. Y.); 11: 1050-8(Mar 1970).

An explicit expression is obtained for the Clebsch–Gordan coefficients which appear in the specification of a basis corresponding to the decomposition of the tensor product of two arbitrary SL(2,C) principal-series representations. Special cases of physical interest are treated in detail. (auth)

20192 RECURSION AND SYMMETRY RELATIONS FOR THE CLEBSCH–GORDAN COEFFICIENTS OF THE HOMOGENEOUS LORENTZ GROUP. Anderson, R. L.; Raczka, R.; Rashid, M. A.; Winternitz, P. (International Atomic Energy Agency, Trieste, Italy). J. Math. Phys. (N. Y.); 11: 1059-68(Mar 1970).

Recursion and symmetry relations are obtained for the Clebsch–Gordan coefficients associated with the coupling of two SL(2,C) principal-series representations. An explicit procedure based on the recursion relations which are not restricted to the case of principal-series representations is given for generating a set of coefficients from a single "initial" coefficient. A program for the study of a possible connection, through analytic continuation, between the coupling coefficients for finite-dimensional representations and those for the infinite-dimensional case is presented. (auth)

20193 REMARKS ON THE EQUATIONS OF MOTION IN ODD-DIMENSIONAL SPACES AND TCP INVARIANCE. Santhanam, T. S. (International Atomic Energy Agency, Trieste, Italy). J. Math. Phys. (N. Y.); 11: 1122(Mar 1970).

It is shown that the problem of TCP noninvariance of the equations of motion in odd-dimensional spaces is connected with the irreducibility of the representations of the Clifford algebra C_{2l+1}. It is further shown that the above difficulty can be overcome by using representations of C_{2l+1}, $l > n$ whether the particle is massive or massless. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 20124.

20194 (CERN–70-1) K^0 DECAY AND CP VIOLATION. Steinberger, J. (European Organization for Nuclear Research, Geneva (Switzerland)). 9 Jan 1970. 24p. Dep. CFSTI (U. S. Sales Only).

A discussion of CP violation in K^0 decay is given phenomenologically and with experimental results. The topics discussed are the relation between $(K,\bar{K})$ and (K_S,K_L), masses, lifetimes, and decay model, the mass matrix, special cases of T, CPT, and CP invariance, unitarity and regeneration. Also covered are the decays $K \to 2\pi$, K_{e3}^0, and $K \to 3\pi$. Finally, CPT invariance, time reversal invariance, isospin analysis of two-pion decay assuming CPT, and some models of CP violation are considered. (J.F.P.)

20195 (NYO–3399-220) SPONTANEOUS BREAKDOWN OF WEAK AND ELECTROMAGNETIC INTERACTION SYMMETRY. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y. Dept. of Physics). [1970]. 23p. (SU–1206-220). Dep. CFSTI.

A unified theory of the weak and electromagnetic interactions of leptons and hadrons is constructed. The underlying symmetry group is taken to be the SU(2) generated by the weak lepton currents and the hadronic Cabibbo currents. This symmetry is destroyed by the spontaneous breakdown mechanism. In the theory, the weak coupling constant is the same as the electromagnetic coupling constant and the mass of the charged intermediate boson is 37.4 GeV. (auth)

20196 MEASUREMENT OF THE CP-VIOLATION PARAMETER η_{00} IN $K_L \to 2\pi^0$ DECAY. Liu, John Kuang-ping. Princeton, N. J.; Princeton Univ. (1968). 202p.

Thesis.

The CP-violating decay mode $K_L \to 2\pi^0$ was studied in a spark-chamber experiment at the Princeton–Pennsylvania Accelerator. The transverse-momentum spectrum of γ-rays observed in a spectrometer was used to separate $K_L \to 2\pi^0$ events from the dominant $K_L \to 3\pi$ decay modes, and these events were then reconstructed kinematically in the K_L center of mass. The branching ratio $(K_L \to 2\pi^0)/(K_L \to 3\pi^0)$ was measured to be $(4.6 \pm 1.1) \times 10^{-3}$. This leads to $(K_L \to 2\pi^0)/(K_L \to \text{all}) = (0.97 \pm 0.23) \times 10^{-3}$, and a CP-violation parameter $|\eta_{00}| = (2.2 \pm 0.3) \times 10^{-3}$. (Diss. Abstr. Int., B)

20197 SPATIAL CORRELATION OF PARTICLES IN MANY-BODY SYSTEMS. Isihara, Akira (State Univ. of New York, Buffalo). Progr. Theor. Phys. (Kyoto), Suppl.; No. 44, 1-68 (1969).

Quantum field theoretical methods are discussed to evaluate the spatial distribution in many-body systems in equilibrium. The pair and triplet distribution functions are explicitly evaluated for noninteracting cases. A general method to evaluate the pair distribution function in the chain and ring diagram approximations for interacting systems is presented in detail. The result is expressed in terms of the eigenvalues of the propagators characteristic of the diagrams. This result generalizes the Gell-Mann and Brueckner formula for the equation of state, the derivation of which is also given. The eigenvalues are evaluated for Boltzmann, Bose and Fermi statistics. Application of the result to a hard-sphere Bose gas is made, and the effect of condensation is studied. It is found that the phonon velocity depends on the number of particles in the lowest state. The distribution functions of a degenerate Fermi system are also calculated. (auth)

20198 MILLISTRONG C VIOLATION AND η DECAY. Frenkel, A. (Central Research Inst., Budapest); Marx, G. Acta Phys. Acad. Sci. Hung.; 27: 87-110(1969).

The isospin properties of the (assumed) millistrong C violation were investigated. The consequences of a $\Delta I = 0$ and $\Delta I = 2$ selection rule are discussed for the $\eta \to \pi^+\pi^0\pi^-$ and $\eta \to \pi^0 e^+ e^-$ decays. If the observed charge asymmetry of the $\eta \to \pi^+\pi^0\pi^-$ is realistic, the C violating 3π final state is mainly an $I = 2$ eigenstate produced by a $\Delta I = 2$ coupling with a constant $g_2 \simeq 10^{-2}$. Since the $I = 0$ eigenstate is here very much suppressed by the centrifugal barrier, the $\Delta I = 0$ coupling may be much stronger, e.g., $g_0 > 10^{-4}$, limited only by the negative results of the $\eta \to \pi^0 e^+ e^-$ experiments. So the $\Delta I = 0$ dominance of the millistrong C violation, suggested by the indication $|\epsilon| > |\epsilon'|$ in the K^0 decays, is by no means in contradiction with the observed $\Delta I = 2$ character of the $\eta \to \pi^+\pi^0\pi^-$ asymmetry. The importance of more accurate experiments is emphasized. (auth)

20199 ELECTROMAGNETIC FORM FACTORS IN SL(n,C)-CALCULATION OF ULTRASPHERICAL POLYNOMIALS. Thornber, N. S. (Univ. of Bristol, Eng.). J. Math. Phys. (N. Y.); 11: 1118-21(Mar 1970).

A simple expression is derived for the functions encountered in electromagnetic form factor calculations done with infinite-component fields. The expression holds for the general case of SL(n,C). The functions are related to Gegenbauer polynomials. (auth)

Applications (Strong)

20200 (ITF-69-82) BROKEN NONLINEAR CHIRAL U(3) x U(3) AND SU(3) x SU(3) DYNAMICS OF HADRONS AND THEIR COROLLARIES. Sabo, V. I.; Lomsadze, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 24p. Dep. CFSTI (U. S. Sales Only).

Broken nonlinear chiral U(3) × U(3) and SU(3) × SU(3) dynamics are built for low-energy strong, electromagnetic and weak interactions of the multiplets B, P, V, and A. Predictions of both dynamics can be estimated to be in satisfactory agreement with experiment for all decays and scatterings up to energies 40 MeV in L-frame. (auth)

20201 DYNAMIC GROUPS AND INFINITE MULTIPLETS IN HADRON THEORY. Olszewski, Jan (Inst. of Physics, Krakow). Postepy Fiz.; 20: 661-99(1969). (In Polish).

The relativistic model of hadrons, proposed by A. O. Barut and his collaborators and based upon the 0 (4,2) conformal group is described in some detail. The group-algebraic theory of the non-relativistic H-atom, including its electromagnetic interaction (in the dipole approximation) is presented, while in the second one the fundamental assumptions and some results of Barut's model are briefly summarized. (auth)

20202 CROSSING MATRICES FOR SU(2) AND SU(3). Rebbi, Claudio; Slansky, Richard (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Rev. Mod. Phys.; 42: 68-86(Jan 1970).

The SU(2) crossing matrices for the scattering of $I = 0, \frac{1}{2}, 1, \frac{3}{2}$ particles and antiparticles, and the SU(3) crossing matrices for the scattering of singlets, octets, and decimets are listed. The s–t, s–u, and t–u crossing matrices and their inverses are given for each case. The relative phases of the crossing matrix are discussed in detail. (auth)

20203 GLOBAL AND INFINITESIMAL NONLINEAR CHIRAL TRANSFORMATIONS. Joseph, A.; Solomon, A. I. (Tel Aviv Univ., Israel). J. Math. Phys. (N. Y.); 11: 748-61(Mar 1970).

The problem of determining arbitrary nonlinear representations of a given compact Lie group is studied with the object of constructing Lagrangians invariant under the group. To achieve this, expressions for the covariant derivatives are obtained and it is shown how previous treatments based on global and on infinitesimal considerations are related. The noncompact case, the relation between nonlinearity and zero-mass particles, and the possibility of embedding the representation manifold in a higher-dimensional space are all discussed. (auth)

Field Theories

General

Refer also to abstract 20103.

20204 THE SPIN-MATRIX-FORM OF ELECTRODYNAMICS IN RELATION TO THE STRUCTURE OF THE LORENTZ GROUP. Bleuler, K.; Garcia, J. R. (Univ., Bonn). Ann. Acad. Sci. Fenn., Ser. A VI; No. 299, 1-13(1969).

The spin matrix form of electrodynamics is deduced in a new way: In a first (intermediate) step the Maxwellian field equations are written in terms of the complex selfdual field tensor G. This tensor (interpreted as a four-dimensional matrix) is reduced by a similarity transformation T in two identical two-by-two spin matrices F. This transformation plays—in the same time—a fundamental role in the structure of the Lorentz group (factorization into two Weyl representations). For this reason a simple relativistic transformation law of the spin-matrices F is obtained. On the other hand the transformation T is intimately related to the Weyl spin matrices and leads immediately to the transcription of the Maxwell equations in terms of F. This fact explains the formal similarity of this matrix form with the Weyl neutrino equation. Within this frame the invariance with respect to space reflections has to be studied separately by introducing the so-called adjoint quantities and the corresponding adjoint Maxwellian spin-matrix equation. (auth)

20205 NONLINEAR ELECTRODYNAMICS: LAGRANGIANS AND EQUATIONS OF MOTION. Boillat, Guy (Univ., Clermont, Clermont-Ferrand, France). J. Math. Phys. (N. Y.); 11: 941-51(Mar 1970).

After a brief discussion of well-known classical fields two principles are formulated. When the field equations are hyperbolic, particles move along rays like disturbances of the field; the waves associated with stable particles are exceptional. This means that these waves will not transform into shock waves. Both principles are applied to nonlinear electrodynamics. The starting point of the theory is a Lagrangian which is an arbitrary nonlinear function of the two electromagnetic invariants. The laws of propagation of photons and of charged particles are obtained along with an anisotropic propagation of the wavefronts. The general "exceptional" Lagrangian is found. It reduces to the Lagrangian of Born and Infeld when some constant (probably simply connected with the Planck constant) vanishes. A nonsymmetric tensor is introduced in analogy to the Born–Infeld theory, and finally, electromagnetic waves are compared with those of Einstein–Schrödinger theory. (auth)

20206 ON THE OPERATIONAL DEFINITION OF RADIATION IN WHEELER–FEYNMAN ACTION-AT-A-DISTANCE ELECTRODYNAMICS. Leiter, Darryl (Boston Coll., Chestnut Hill, Mass.). Amer. J. Phys.; 38: 207-12(Feb 1970).

The basic structure of Wheeler–Feynman "action-at-a-distance" electrodynamics is reviewed in an attempt to better understand the details of how the process of radiation is described in this theory. In action-at-a-distance electrodynamics, radiation is not associated with a single current, but instead involves both an "emitter" charge and a "receiver" charge in its definition. This process is studied in detail, and the exact manner in which this definition of radiation can be made to agree with the conventional Maxwell–Lorentz definition of radiation is shown. As a practical

example of this definition of radiation, the Rayleigh–Jeans blackbody radiation law is derived within the Wheeler–Feynman electrodynamic framework. (auth)

Quantum Field Theory

Refer also to abstracts 19733, 20102, 20253, 20256, and 20263.

20207 (NYO–3829–44) PROBLEMS OF STABILITY FOR QUANTUM FIELDS IN EXTERNAL TIME-DEPENDENT POTENTIALS. Schroer, Bert; Seiler, Rudolf (Pittsburgh Univ., Pa. Dept. of Physics); Swieca, Jorge Andre (Sao Paulo Univ. (Brazil)). Dec 1969. 39p. Dep. CFSTI.

Existence proofs are given for the unitary time evolution operator for various quantized fields interacting with external fields. For interactions finitely extended in time there are no problems with indefinite metric provided certain conditions are met. The Rarita–Schwinger- and Pauli–Fierz-equations are of this type. In the case of interactions $s \geq 3/2$ these equations have the well known consistency and causality troubles. Other equations, for example, the Joos–Weinberg equation, are shown to lead to different troubles. (auth)

20208 BETHE–SALPETER EQUATION AND THE GOLDSTEIN PROBLEM. Keam, R. F. (Univ. of Auckland, N. Z.). J. Math. Phys. (N. Y.); 11: 394–403(Feb 1970).

The Goldstein problem for the ladder-approximation Bethe-Salpeter equation for a spin-$\frac{1}{2}$ fermion-antifermion system bound to zero total mass by particle exchange is re-examined. It is suggested that the problem arises because attention has previously been focused on the wrong Dirac-space sectors of the equation. Criteria limiting the acceptable behavior of solutions are investigated and it is shown that discrete spectra for the values of the coupling constant are allowed to exist for the T–A sector and S–V sector solutions. Continuous spectra are always excluded. (auth)

20209 EXPONENTIAL HILBERT SPACE: FOCK SPACE REVISITED. Klauder, John R. (Bell Telephone Labs., Murray Hill, N. J.). J. Math. Phys. (N. Y.); 11: 609–30(Feb 1970).

An exponential Hilbert space, which is an abstraction of the familiar Fock space for bosons, provides a natural framework to discuss a wide class of field-operator representations. This framework is especially convenient when wide invariance groups, such as a unique translationally invariant state, are involved. The theory of exponential Hilbert spaces is developed in a functional fashion suitable to discuss representations of field operators enjoying such invariance features. Representations of both current algebras and canonical field operators are discussed, and it is shown that these representations are natural generalizations of those characterizing infinitely divisible random processes. Questions of reducibility and equivalence are treated, and it is proved that the construction gives rise to infinitely many unitarily inequivalent representations. Nevertheless, an extremely simple expression, bilinear in annihilation and creation operators, abstractly characterizes the operators of both the current algebras and canonical fields. Dynamical applications to quantum field theory will be treated in subsequent papers. (auth)

20210 STRESS-TENSOR COMMUTATORS IN NONLINEAR ELECTRODYNAMICS. Deser, S.; Morrison, L. K. (Brandeis Univ., Waltham, Mass.). J. Math. Phys. (N. Y.); 11: 596–602 (Feb 1970).

Equal-time stress-tensor commutators are shown to have a simple form for general systems of spin zero and one. Electrodynamics with arbitrary self-coupling is treated in detail. Ordering and other problems of a purely quantum nature are not discussed. (auth)

20211 EXACT STATIONARY STATES IN LOCAL RELATIVISTIC FIELD THEORIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). J. Math. Phys. (N. Y.); 11: 536–8(Feb 1970).

For theories featuring n scalar fields and an interaction energy density that converges rapidly for large field magnitudes to the form representative of a linear theory, exact physical solutions to the Schrödinger stationary state equation are presented. These solutions show that such quantum field theories are effectively linear with no interaction and scattering between the quanta. (auth)

20212 NOTE ON RELATING PFAFFIANS AND HAFNIANS WITH DETERMINANTS AND PERMANENTS. De Luca, A. (Laboratorio di Cibernetica, Naples); Ricciardi, L. M.; Vasudevan, R. J. Math. Phys. (N. Y.); 11: 530–5(Feb 1970).

In connection with renormalization problems in quantum field theory, Pfaffians and Hafnians are considered. It is given a noteworthy expansion of determinants and permanents, in terms of Pfaffian-like and Hafnian-like objects, that immediately leads to the known reduction of a determinant to a single Pfaffian. Finally, some auxiliary results are presented. (auth)

20213 SPETSIAL'NAYA TEORIYA OTNOSITEL'NOSTI. (Special Theory of Relativity). Ugarov, V. A. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1969). 304p.

An attempt was made to present in a simplest form the special theory of relativity. The analysis of relativistic concepts, Laurentz transformation and its consequences are covered. The mechanics of variations in the theory of relativity and the four-dimensional form of the Maxwell theory are also covered. Geometric interpretation of the special theory of relativity and paradoxes in the special theory of relativity are discussed. The various problems, rules, and mathematical determinations are included. A short comprehensive list of terms is included. (59 references) (R.V.J.)

20214 NOTES TOWARDS THE CONSTRUCTION OF NONLINEAR RELATIVISTIC QUANTUM FIELDS. II. THE BASIC NONLINEAR FUNCTIONS IN GENERAL SPACE–TIMES. Segal, Irving (Massachusetts Inst. of Tech., Cambridge). Bull. Amer. Math. Soc.; 75: 1383–9(1969).

The renormalized products of quantum fields are extended to general space–time and laws of dependence of the energy on the momentum. It is noted that the relativistic theory in a Minkowski space of any dimension is a special case. (J.F.P.)

20215 SOME COMMENTS ON THE GENERALIZED ENERGY-MOMENTUM EIGENVECTORS IN THE AXIOMATIC FIELD THEORY. Kolm, A. (Royal Inst. of Tech., Stockholm). Ark. Fys.; 39: 551–71(1969).

The notion of generalized eigenvector to the energy-momentum operator was considered in the framework of the axiomatic field theory. The mathematical structure of such a eigenvector was studied and the existence of a complete generalized eigenvector system was used to get a relation between these eigenvectors and the vacuum expectation value. In the simplest case this relation coincides with the Kaellén–Lehmann representation of the two-point function. Other applications of the relation are also demonstrated. Finally the generalized energy-momentum eivenvectors in the case of a free scalar field are discussed in some detail. (auth)

20216 NOTES TOWARDS THE CONSTRUCTION OF NONLINEAR RELATIVISTIC QUANTUM FIELDS. III. PROPERTIES OF THE C*-DYNAMICS FOR A CERTAIN CLASS OF INTERACTIONS. Segal, Irving (Massachusetts Inst. of Tech., Cambridge). Bull. Amer. Math. Soc.; 75: 1390–5(1969).

The C* dynamics of positive-energy symmetric (Bose–Einstein) quantum fields is treated in continuation of previous work. While the construction of nonlinear relativistic quantum fields is mainly considered, other possible formulations of space–time are also investigated. (J.F.P.)

20217 THE NATURE OF FASTER-THAN-LIGHT PARTICLES AND THEIR INTERACTIONS. Sudarshan, E. C. G. (Delhi Univ.). Ark. Fys.; 39: 585–91(1969).

Faster-than-light particles, tachyons, are described in a classical as well as a quantum theoretical picture using a Klein–Gordon equation with imaginary mass. For an invariant quantization of the associated field only annihilation operators are used. A particular case of tachyon-nucleon coupling with Yukawa interaction is considered. Detection experiments based on strong interaction of tachyons are suggested.

20218 NOTE ON THE TROUTON–NOBLE EXPERIMENT. Strnad, J. (Univ. of Ljubljana, Yugoslavia. Nuclear Inst. Josef Stefan, Ljubljana, Yugoslavia). Contemp. Phys.; 11: 59–64(Jan 1970).

In this short communication the Trouton-Noble experiment is considered first in the classical ether theory. Going over to the special theory of relativity, one encounters some difficulties in describing the null result. A simple explanation of this result is given in terms of the principle of virtual work, introduced recently in this context by J. H. Fremlin. (auth)

20219 COMPLETENESS AND THE LEE MODEL WITH INDEFINITE-METRIC THEORIES. Bui-Duy, Q. (McGill Univ., Montreal). Nuovo Cim.; 66A: 313–22(21 Mar 1970).

Indefinite-metric theories with complex ghosts and dipole ghosts are studied in the $N\theta$ sector and the $NN\theta$ sector of the Lee model with regard to completeness. It is shown that, in the $N\theta$ sector, the eigenstates of the pseudo-Hermitian Hamiltonian form a complete set in the complex-ghost case whereas in the dipole-ghost case they do not. In the $NN\theta$ sector it is shown that the energy eigenstates do not form a complete set in both cases. (auth)

20220 ASYMPTOTIC FORM OF n-th-ORDER SPENCE FUNCTIONS. Perrin, R. (Brandeis Univ., Waltham, Mass.). Nuovo Cim.; 66A: 362-70(21 Mar 1970).

The constant terms in the large-amplitude expansions of n-th-order Spence functions are derived. The results are then used to relate the perturbation coefficients in the high-energy expansions of the renormalized Green's functions and the renormalization constants in quantum electrodynamics. (auth)

20221 LAGRANGIAN FORMULATION OF THE ZACHARIASEN MODEL WITH A CDD POLE. Lukierski, J. (CERN, Geneva); Turko, L. Nuovo Cim.; 66A: 409-23(21 Mar 1970).

The generalization of Thirring's formulation of the Zachariasen model in the presence of a CDD pole is given. The local field operator, describing an interacting CDD particle, is introduced. It is shown that the CDD pole can be interpreted as a particle only if the mass renormalization in the Zachariasen model is finite. (auth)

20222 RELATIVITE ET QUANTA. LES GRANDES THEORIES DE LA PHYSIQUE MODERNE. (Relativity and Quanta. The Great Theories of Modern Physics). Costa de Beauregard, O.; Daudel, R.; Hillion, P.; Jouvet, B.; Kichenassamy, S. A la Meme Librarie. Paris; Masson et Cie Editeurs (1968). 237p. 65 F.

The discussion of relativity and quanta covers special and general relativity theory, wave mechanics and quantum field theory, quantum field theory and dynamic theories of matter. Also wave mechanics of the atom and molecule, classification of elementary particles and their interactions, and radiation detectors are included. (J.F.P.)

20223 WARD IDENTITIES AND VERTICES IN THE OPERATORIAL DUALITY FORMALISM. Caneschi, L. (Univ. of California, Santa Barbara); Schwimmer, A. Lett. Nuovo Cim.; 3: 213-17(12 Feb 1970).

The generalized gauge transformation operator is used to obtain simple forms for the twisted tree diagrams and to factorize completely the three-Reggeon vertex. (L.B.S.)

20224 INVARIANT FUNCTIONS AND SPECTRAL REPRESENTATIONS. Goldberg, I.; Marx, E. (Drexel Inst. of Tech., Philadelphia). Lett. Nuovo Cim.; 3: 277-8(26 Feb 1970).

Some of the problems that are usually overlooked in the use of spectral representations for vacuum expectation values of products of operators are pointed out. Certain assumptions made concerning the Lorentz invariant function and the vacuum expectation value of a divergenceless second-rank tensor operator are shown to be in contradiction with certain specific examples. (L.B.S.)

20225 SPECIAL RELATIVITY AND DIAGONAL TRANSFORMATIONS. Parker, Leonard; Schmieg, Glenn M. (Univ. of Wisconsin, Milwaukee). Amer. J. Phys.; 38: 218-22(Feb 1970).

The form of the special Lorentz transformation, and the corresponding transformation of the electromagnetic field, in which the transformation matrix is diagonal are discussed. The diagonal form of the special Lorentz transformation is derived directly, in a simple way, and it is shown that it is sometimes more convenient to apply than the algebraically equivalent conventional form of the transformation. The convenience is especially evident in deriving the linear Doppler effect, and the relativistic addition of more than two parallel velocities. By writing Maxwell's equations in terms of linear combinations of coordinates which have simple transformation properties, we arrive at the transformation equations of the Maxwell fields in a diagonal form, as well as at the plane wave solutions, in a natural manner. The derivations and applications described above should be of use in a course on relativity because of their simplicity and directness. (auth)

20226 TOWARD A GENERAL THEORY OF MEASUREMENT. I. Horst, David R. (State Univ. of New York, Buffalo). J. Math. Phys. (N. Y.); 11: 851-5(Mar 1970).

A self-consistent measurement theory is set forth in this paper, which can be applied to the problem of measurement in field theory. Following the formulation of Birkhoff and von Neumann, a system of axioms is constructed sufficient to ensure that it is possible to find an implicit mechanism within each theory for the experimental procedure corresponding to each observable proposition of that theory. It is shown that any theory of a type similar to quantum mechanics cannot consistently describe a closed system from the point of view of a single observer. (auth)

20227 SOME REMARKS ON CLASSICAL SCALAR RADIATION FROM POINT SOURCES. Cawley, Robert G. (Naval Ordnance Lab., Silver Spring, Md.). J. Math. Phys. (N. Y.); 11: 761-5(Mar 1970).

The radiation from a point source with proper time-dependent coupling strength to a real classical scalar field is worked out. The adiabatic switching limit reproduces the results of the physical case of constant coupling for the radiation. The problem of defining a "radiated" field is discussed. (auth)

Gravitation and General Relativity

Refer also to abstracts 19693, 19702, 20020, and 20027.

20228 COUPLING GRAVITATIONAL RADIATION TO NONRELATIVISTIC SOURCES. Burke, William Lionel. Pasadena, Calif.; California Inst. of Tech. (1969). 119p.

Thesis.

The problem of the coupling of gravitational radiation to its sources is examined in the limit of weak fields and slowly moving sources; it shows in detail how the irreversibility caused by the escape of radiation can be included in the formalism. The usual slow-motion expansions of general relativity (EIH and post-Newtonian) have the difficulty that they are not uniformly valid for large distances—distances where radiation becomes important and where the outgoing-wave boundary condition must be imposed. This difficulty is eliminated by using the method of matched asymptotic expansions. A second asymptotic expansion, in the same slowness parameter as enters in the near zone, is used to represent the radiation. This outer expansion provides matching conditions on the inner expansion that generate radiative corrections to the inner expansion. Using this technique it is shown that the escape of radiation leads to an extraction of energy from the sources, without ever having to define the energy carried in the gravitational waves. The damping is found by calculating the work done by the fields that react back on the source. Explicit expressions are given for these fields, and these can be used to calculate, in lowest order, all the irreversible effects caused by radiation. The problem of calculating radiation reaction for bodies with very weak gravitational fields ($U/c^2 << v^2/c^2 << 1$) is solved definitely. The case of gravitationally bound systems ($U/c^2 \approx v^2/c^2 << 1$) is discussed and a program for dealing with this case is set up, but the calculations for this case have not yet been done. (Diss. Abstr.)

20229 GRAVITATIONAL RADIATION: CUTTING THE TAIL. Hallidy, William H.; Janis, Allen I. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.); 11: 578-89(Feb 1970).

Using the Newman-Penrose spin-coefficient approach to gravitational radiation, necessary conditions are considered for stationary-radiative-stationary transitions to occur between states in a Riemannian space-time which satisfies the empty-space Einstein field equations everywhere outside of a spatially bounded timelike cylinder. It is found that for axially symmetric radiation of finite multipole expansion such transitions cannot occur; however, a model has been constructed for nonaxially symmetric radiation for which these transitions can occur to a certain asymptotic order in a relevant parameter while satisfying the Newman–Penrose conservation laws. (auth)

20230 SOLUTIONS OF TWO PROBLEMS IN THE THEORY OF GRAVITATIONAL RADIATION. Chandrasekhar, S. (Univ. of Chicago). Phys. Rev. Lett.; 24: 611-15(16 Mar 1970).

The evolution of an elongated rotating configuration by gravitational radiation and the possibility of a secular instability being induced by it are considered in the context of the classical homogeneous figures of Maclaurin and Jacobi. The triaxial Jacobian ellipsoid evolves in the direction of increasing angular velocity and approaches (exponentially) the point of bifurcation where it ceases to radiate. Further, radiation reaction does not make the Maclaurin spheroid secularly unstable past the point of bifurcation. (auth)

20231 EINSTEIN–MAXWELL FIELDS WITH PLANE SYMMETRY. I. Patnaik, S. (Univ., Montreal). Proc. Cambridge Phil. Soc.; 67: 127-31(1970).

An exact static solution of the system of Einstein–Maxwell field equations in the absence of charge is obtained when both the metric tensor $g_{\alpha\beta}$ and the Maxwell field tensor $F_{\alpha\beta}$ exhibit plane symmetry in the sense that both remain invariant under the group of motions that characterize plane symmetry. This solution generalizes the empty space–time solution with plane symmetry previously obtained by Taub to the situation when static charge-free electromagnetic fields are present. (auth)

20232 EQUATIONS OF MOTION IN GENERAL RELATIVITY. Synge, J. L. (Dublin Inst. for Advanced Studies). Proc. Roy. Irish Acad., Sect. A; 69: 11-(1970).

Equations of motion are obtained for a system of massive bodies of finite size moving in the gravitational field of the system. In the Eulerian form of Newtonian mechanics there are ten field vari-

ables representing density, velocity and stress, and they satisfy four equations of motion (including mass-conservation). In general relativity there are twenty field variables (the components of the metric tensor g_{ab} and the energy tensor T^{ab}), and they satisfy four equations of motion $T^{ab}{}_{;b} = 0$, which involve not only T^{ab} but also g_{ab} through Christoffel symbols. The essential feature is a technique to find g_{ab} as functionals of T^{ab}, so that the equations of motion involve only the ten components T^{ab}. The equations of motion can then be compared with the classical Eulerian equations and in this way the deviations of relativistic mechanics from Newtonian mechanics are revealed in a systematic way. In this technique Einstein's field equations are relaxed and replaced by recurrence formulae. Approximations are based on the weakness of the field (densities are small in a technical sense). The process may be carried through any number of steps, but the formulae become complicated, and, for interesting results, it suffices to stop at the third approximation. Thus equations of motion in first approximation (gravity inoperative), second approximation (differing from Newtonian equations only in the possibility of small changes in mass), and third approximation (here relativistic effects are significant) are obtained. At each stage there is a model universe equipped with a metric tensor g_{ab} and an energy tensor T^{ab}, and the relativistic validity of the model may be tested by calculating the error tensor $E^{ab} = T^{ab} + k^{-1}G^{ab}$, which should of course vanish in a perfect model. Except for a simple check of the equations of motion in the case of a small planet moving round a fixed massive sun, applications are deferred to a later communication. (auth) (UK)

20233 SYNCHRONIZATION OF CLOCKS IN THE GENERAL RELATIVITY THEORY. Arifov, L. Ya.; Bespalova, N. S. Zh. Eksp. Teor. Fiz.; 58: 568-72(Feb 1970). (In Russian).

The possibility of a global description of space-time relations in the four-dimensional continuum of the theory of relativity is investigated. For this purpose a time function and space equation as hypersurfaces of simultaneous points are introduced. (auth)

20234 QUESTIONS CONCERNING THE THEORY OF RELATIVITY. Cornelius, F. Neue Phys.; 5: No. 1-2, 35-43(1968-69). (In German).

Discussion of Einstein's theory of relativity is presented. It is argued that the spherical space of the theory of relativity is obtained by a mathematical operation which is not permissible. It is claimed that the Lorentz transformation has been misinterpreted. Other conclusions from the theory of relativity are also questioned, for instance, those related to time at relativistic velocities. (IAA)

20235 IS POINCARE INVARIANCE COMPATIBLE WITH GENERAL RELATIVITY? Sueveges, M. (Research Group for Theoretical Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 27: 261-8(1969).

It was previously shown that an invariance principle is defined in curved space by invariance under the Brandt groupoid consisting of elements given by parallel displacements along all possible curves in space-time. It is argued that the Brandt groupoid might contain the Poincaré group as a local group in each tangent space but then space-time must have nonvanishing torsion. Such a conclusion might also be implied by recent measurements of Sadeh et al. For an Einstein manifold, on the other hand, the Brandt groupoid contains only the homogeneous Lorentz group. (auth)

20236 GENERAL RELATIVISTIC THIN-SANDWICH THEOREM. Komar, Arthur (Yeshiva Univ., New York). J. Math. Phys. (N. Y.); 11: 820-1(Mar 1970).

The configuration variables for the gravitational field g_{mn} are assigned arbitrarily on two infinitesimally neighboring spacelike hypersurfaces. Then the extent to which a solution of the vacuum Einstein field equations can be found consistent with the given assignment is investigated. A local approach, employing Dirac's Hamiltonian formalism, reveals that solutions can be found locally which are nonunique and highly unstable. (auth)

20237 CURVATURE COLLINEATIONS IN EMPTY SPACE-TIMES. Collinson, C. D. (Univ. of Hull, Eng.). J. Math. Phys. (N. Y.); 11: 818-19(Mar 1970).

It is shown that the only curvature collineations admitted by an empty space-time, not of Petrov type N, are conformal motions. The curvature collineations admitted by the plane-fronted gravitational waves are found. (auth)

20238 INFILLING FOR NUT SPACE. Jackson, J. C. (King's Coll., London). J. Math. Phys. (N. Y.); 11: 924-30(Mar 1970).

A method of generating interior NUT solutions from spherically symmetric ones is presented. It is similar to the well-known "derivation" of the corresponding vacuum metric from the Schwarzschild solution. These sources turn out to consist of material bridges, joining otherwise independent vacuum regions through a "wormhole." It is shown that this manner cannot have an equation of state which is physically reasonable everywhere. (auth)

20239 THREE-DIMENSIONAL CHRONOMETRIC INVARIANT DIMETRIC FORMALISM IN THE GENERAL THEORY OF RELATIVITY. Barynin, V. A. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 6, 92-7(Nov-Dec 1969). (In Russian).

A tri-dimensional chronometrically invariant dimetric formalism, which confers on all magnitudes of the general theory of relativity the invariant properties in relation to the arbitrary time converters and purely spatial coordinates, was obtained. In contrast to the ordinary dimetric formalism this formalism was held in respect to transformation coordinates and time which were devoid of physical content. (tr-auth)

Scattering Theory

Refer also to abstracts 20023, 20148, and 20186.

20240 (BNL-50212, pp 73-120) RIGOROUS PROPERTIES OF AMPLITUDES AT HIGH ENERGIES. Khuri, N. N. (Brookhaven National Lab., Upton, N. Y.).

A review is presented of the rigorous bounds and other asymptotic properties of scattering amplitudes at high energies. The known analyticity and crossing results are stated without proof. Bounds, inequalities, and asymptotic relations for the scattering amplitudes are then derived. (J.F.P.)

20241 (BNL-50212, pp 121-57) DYNAMICAL MODELS BASED ON CLASSICAL LIMITS. Arnold, R. C. (Argonne National Lab., Ill.).

Previous attempts to explain high-energy data using classical intuition and Regge behavior are considered. The topics covered include the general features of two-body interactions, scattering by composite systems, absorptive formula, effective potential and the optical model, Regge exchange, and the hybrid or absorption model. Also included are a comparison of models, production theories, and dielectric spheres and sharp boundary models. (J F.P.)

20242 (BNL-50212, pp 249-86) DYNAMICAL MODELS BASED ON UNITARITY AND ANALYTICITY. Frazer, W. R. (California Univ., La Jolla, San Diego).

A review is given of some S-matrix properties including the analytic structure and concept of pology. Bootstrap theories including the N/D method and the ρ bootstrap of Chew and Mandelstam are discussed. Some specific models such as the Bethe-Salpeter equation and its implicit O(4) symmetry, and the multi-Regge model in its simplest version are covered. (J.F.P.)

20243 (BNL-50212, pp 385-481) RECENT DEVELOPMENTS DUALITY AND HADRON DYNAMICS. Harari, H. (Brookhaven National Lab., Upton, N. Y.).

A step by step review is given of the historical and logical developments of the various aspects of duality. The assumptions used are emphasized. (J.F.P.)

20244 (COO-264-536) FACTORISATION OF SATELLITE TERMS IN THE N-PARTICLE DUAL AMPLITUDE. Frampton, P. H. (Chicago Univ., Ill. Enrico Fermi Inst.). Feb 1970. 10p. (EFI-70-8). Dep. CFSTI.

Complete factorization of the N-particle dual amplitude with satellite terms is exhibited explicitly in a formalism using harmonic-oscillator-like creation and destruction operators. (auth)

20245 (COO-1573-66) A POSSIBLE DIFFICULTY WITH THE "EIKONAL PICTURE" OF HIGH ENERGY INTERACTIONS. Kantor, P. B. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). [1969]. Contract AT(11-1)-1573. 8p. Dep. CFSTI.

An heuristic argument is presented suggesting that at high energies the effect of multiple scattering off the energy shell becomes important for an understanding of the propagation of one elementary particle through another. (auth)

20246 (ITF-69-83) THE CONNECTION OF THE KINEMATICAL CUT WITH THE S-MATRIX ON THE MASS SHELL FOR THE TWO CHANNEL SCATTERING. Kharakhan, M. L.; Shirokov, Yu. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 13p. (In Russian). (CONF-690417-23). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

An explicit expression is derived connecting the physical S-matrix with the jump through the kinematical out of the matrix

element $\langle 2/H(x)10\rangle$ of the scalar field for the two channel case. This is the direct generalization of a previous corresponding result for the one-channel case. (auth)

20247 (UCRL-6734) SCATTERING THEORY. A Series of Six Lectures Presented at Lawrence Radiation Laboratory, Livermore, California, in 1961. Lippmann, Bernard A. (California Univ., Livermore. Lawrence Radiation Lab.). 5 Jan 1962. 60p. Dep. CFSTI.

The physical ideas underlying time-dependent scattering theory for a system of two interacting parts are discussed. A mathematical description follows; in this description the collision operator is used to connect the initial and final states of the system. Time-independent theory is then introduced by considering stationary states. The transition probability is calculated. A description in terms of ordinary wave functions is developed from that in terms of abstract-state vectors, and connection is made with the usual scattering amplitude. Application of the theory is made to a scattering process in which two potentials are present, particularly to direct reactions. Rearrangement collisions and the post-prior discrepancy are discussed. (auth)

20248 PERTURBATION THEORY FOR LARGE COUPLING CONSTANTS APPLIED TO THE GAUSS POTENTIAL. Mueller, Harald J. W. (American Univ., Beirut). J. Math. Phys. (N. Y.); 11: 355-64(Feb 1970).

As an example of a perturbation technique for large coupling constants g^2, the solutions and eigenvalues of the Schrödinger equation for a Gauss potential are investigated. In particular, the regular solution, valid for $r^2 < 1/|g|$, is obtained in terms of confluent hypergeometric functions by expanding the potential in the neighborhood of the origin. The Jost solution is obtained in an analogous manner in terms of a certain integral and is valid for $r^2 > 1/|4g|$. Both solutions are eigensolutions belonging to the same eigenenergy $E = k^2$. These eigenvalues are derived in the form of large-g asymptotic expansions which are useful and valid over a wide range of g. A noteworthy aspect of the investigation is the close analogy of the underlying mathematics with that of well-known periodic equations. (auth)

20249 EVALUATION OF A UNITARY INTEGRAL. II. MANDELSTAM ITERATION. Dilley, James (Univ. of Alberta, Edmonton). J. Math. Phys. (N. Y.); 11: 475-6(Feb 1970).

The methods of a previous communication are used to derive a general expression for the first Mandelstam iteration of inputs of the form $A_t(s,t) = \Sigma_j g_j(s,t)\delta(t - t_{Rj})$, where the sum is over terms representing t-channel resonances in narrow-width approximation. The coefficients $g_j(s,t)$ can be either analytic in s, as for an expansion in t-channel partial waves, or meromorphic in s, as in a Padé- or Schlessinger-type expansion. (auth)

20250 VARIATIONAL METHODS IN POTENTIAL SCATTERING. Morawitz, Hans (IBM Research Lab., San Jose, Calif.). J. Math. Phys. (N. Y.); 11: 649-56(Feb 1970).

A comparison of a variety of standard variational methods with a new method due to Harris is made with a view towards selection of the optimal method to be used in realistic many-body scattering calculations. Numerical results for two short-range potentials, the attractive exponential and the attractive Yukawa potential, are given and compared with exact results obtained analytically or by direct numerical integration. It is demonstrated by calculation that the source of an anomaly observed in earlier studies by Schwartz is not due to the attributed reason and, furthermore, the Kohn method is found to be significantly more accurate at the Harris eigenvalues than any of the other methods. Therefore, the use of the Kohn method at the eigenvalues of the matrix Hamiltonian in the trial function subspace is proposed as the optimal method to be used in variational scattering calculations. (auth)

20251 ON THE INVERSE PROBLEM FOR THE KLEIN-GORDON s-WAVE EQUATION. Degasperis, Antonio (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.); 11: 551-67(Feb 1970).

The s-wave Klein-Gordon equation of a particle in an electric-like, spherically symmetrical, local, and energy-independent potential is studied with the aim of deriving exact relationships between the potential and the experimental data. The value of the potential and of all its derivatives at the origin as explicit functionals of the phase shift of the particle and the antiparticle and of their bound-state parameters is obtained. Furthermore, a set of infinitely many nonlinear sum rules are found for the phase shift and the bound-state parameters of both the particle and the antiparticle; these sum rules embody the requirement that the potential be electriclike. This restriction on the potential is also briefly discussed in the framework of the Gel'fand-Levitan approach to the inverse problem. (auth)

20252 REGGE CUTS, SCHMID LOOPS, AND RESONANCE BUMPS. Drago, F. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev. Lett.; 24: 622-5(16 Mar 1970).

The effects of the cuts correction to Regge-pole amplitudes are investigated at intermediate energies. It is shown that, as a consequence of this correction, "resonance" bumps appear in total cross sections. (auth)

20253 ON THE GREEN'S FUNCTIONS FOR THE BETHE-SALPETER EQUATION. Huang, Justin C.; DeFacio, Brian (Univ. of Missouri, Columbia). J. Math. Phys. (N. Y.); 11: 715-24(Feb 1970).

Four possible Green's functions of the Bethe-Salpeter equation for equal mass scalar bosons were studied by considering contours in an off-the-mass-shell complex energy (Ω) plane and an on-the-mass-shell magnitude of 3-momenta (k) or energy (ω_k) complex plane. It was found that three of the Green's functions — causal, retarded, and advanced Green's function — cannot lead to scattering solutions. Only a new Green's function, which is called the scattering Green's function, with appropriate restrictions on the interaction V(x), can lead to scattering states. (auth)

20254 OFF-SHELL SOLUTION OF SCATTERING EQUATIONS. Brayshaw, David Douglas. New York; Rockefeller Univ. (1968). 148p.

Thesis.

A new method of solving scattering equations is developed, which enables one to explicitly exhibit the off-shell solutions. Results are derived for nonrelativistic scattering for superpositions of exponential and Yukawa potentials. The representation obtained for the partial-wave amplitude is used to prove meromorphy of this amplitude in the l-plane, and to prove in a particularly simple manner some well-known results by Regge. The technique is easily generalized to other equations and potentials; in particular, the solution to the Blankenbecler-Sugar equation is obtained. Some especially interesting applications are to be found within the three-body formalism recently developed by Faddeev. This formalism and an approximation to it suggested by Lovelace are described in some detail. The three-body equations are then analyzed by means of the above method. This approach is used to establish a possible connection between some three-body resonances and rescattering singularities related to two-body resonances. A new integral equation is derived for the three-body amplitude which possesses several important advantages over the original Faddeev-Lovelace equation. An application of the above results to a nuclear problem is studied. The system of three alpha-particles is considered within the Faddeev-Lovelace formalism. A connection is established between rescattering singularities related to observed states of ^{8}Be and excited states of the ^{12}C nucleus. (Diss. Abstr.)

20255 LORENTZ POLES AT ZERO ENERGY IN THE UNEQUAL-MASS SCATTERING AMPLITUDE. Toth, K. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim.; 66A: 323-35(21 Mar 1970).

An expansion of the scattering amplitude is given with respect to Lorentz representations. It turns out that an infinite number of Lorentz poles must exist for which $j_0 + \sigma$, the sum of the Lorentz quantum numbers is fixed. (auth)

20256 THE PROBLEM OF THE EXISTENCE OF A SCATTERING S-MATRIX. I. Rayski, J. (Jagellonian Univ., Krakow). Acta Phys. Pol.; A37: 269-74(Feb 1970).

The concept of the S-matrix is ambiguous unless the scattering process is expressed first in terms of wave packets and then a well defined limit transition is performed. This limit transition is necessary but not a sufficient condition for the existence of the S-matrix. It may happen that in a satisfactory theory a unique limit transition exists for probabilities, but does not exist for probability amplitudes. (auth)

20257 DISPERSION RELATION DYNAMICS. A PHENOMENOLOGICAL INTRODUCTION TO S-MATRIX THEORY. Burkhardt, Hugh. New York; John Wiley and Sons, Inc. (1969). 296p. $18.50.

An exposition of S-matrix theory is given. This discussion includes complex variable analysis, phenomenological collision theory, and S-matrix dynamics. (J.F.P.)

20258 SOME REMARKS ON INFINITE VENEZIANO REPRESENTATIONS. Ferrara, S.; Grillo, A. F. (CNEN, Rome). Lett. Nuovo Cim.; 3: 176-9(5 Feb 1970).

Some properties of a class of integral representations describing dual-resonance amplitudes, mainly in connection with the generalization of the Veneziano amplitude to a series of satellite terms, are pointed out. (L.B.S.)

20259 NONPHYSICAL REGION SINGULARITIES OF THE S MATRIX. Goddard, Peter (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.); 11: 960-74(Mar 1970).

Previous work in which the relation between the assumption of Cutkosky-type discontinuity formulas to the positive-α condition for the singularity of anomalous thresholds was examined is extended using more powerful methods. The method is first described in general terms. It is then justified using homological techniques, and specific expressions are calculated for distortion terms. Finally, some specific cases are considered and more elaboration versions of the cancellation processes previously found are shown to occur. (auth)

20260 APPLICATION OF ITERATION TECHNIQUE TO THE INTEGRAL EQUATIONS OF SCATTERING THEORY. Doleschall, P.; Revai, J. (Central Research Inst. for Physics, Budapest). J. Math. Phys. (N. Y.); 11: 1001-2(Mar 1970).

An iterative method based on the generalization of the Fredholm reduction is developed for the solution of the integral equations of the scattering theory. (auth)

20261 ON THE INVERSE SCATTERING PROBLEM AT FIXED ENERGY FOR POTENTIALS HAVING NONVANISHING FIRST MOMENTS. Cox, Joseph R. (Florida Atlantic Univ., Boca Raton); Thompson, Kerris W. J. Math. Phys. (N. Y.); 11: 805-14(Mar 1970).

It has been shown previously by Newton that his solution (and its extension by Sabatier) of the problem of finding a central potential from a knowledge of all phase shifts at fixed energy yields a series whose expansion coefficients converge slowly unless the first moment of the potential vanishes. In particular, any truncation of the series after a finite number of terms necessarily results in potentials which have vanishing first moments. A new, but formally somewhat similar, series is proposed for the potential which, for such truncation, does not suffer from this physically rather severe restriction. The series also furnishes new exact solutions of the Schrödinger equation at fixed energy. A closed-form expression for the scattering amplitude is obtained for a specific example. The problem of constructing the new series from the phase shifts is not discussed. (auth)

20262 NOTE ON THE UNIQUENESS OF THE SOLUTION OF AN EQUATION OF INTEREST IN THE INVERSE SCATTERING PROBLEM. Cox, Joseph R. (Florida Atlantic Univ., Boca Raton); Thompson, Kerris W. J. Math. Phys. (N. Y.); 11: 815-17(Mar 1970).

It is proved that the solutions recently obtained by the authors [J. Math. Phys. 11, 805 (1970)] of the Regge–Newton integral equation (of interest in connection with the inverse scattering problem at fixed energy) are, for a given kernel, inhomogeneity, and boundary condition, uniquely determined. (auth)

20263 FACTORIZATION OF THE DUAL-RESONANCE MODEL WITHOUT SPURIOUS STATES. Brower, R. C.; Weis, J. H. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Lett. Nuovo Cim.; 3: 285-91(26 Feb 1970).

It is shown how to explicitly exhibit the absence of spurious intermediate states in the factorization of the dual Reggeized resonance amplitudes by modifying the vertex so that it decouples from them. Only the vertex with two excited states is treated, but it is indicated how to treat the general three-resonance vertex in a similar manner. The proper elimination of spurious states not only demonstrates multiple factorization on the real subspace, but is important for the construction of off-mass-shell amplitudes. (L.B.S.)

Particle Accelerators

Refer also to abstracts 18901, 20096, 20340, and 20382.

20264 (BNL-14447) STATIONARY CYLINDRICAL BEAM UNDER SPACE-CHARGE CONDITIONS. Claus, J.; Benton, A. (Brookhaven National Lab., Upton, N. Y.). 2 Jan 1970. 16p. Dep. CFSTI.

Self-consistent charge distributions and two-dimensional emittances for a beam with cylindrical symmetry and a uniform density in four-dimensional phase space moving in a smoothly approximated focusing system are obtained by direct integration. (auth)

20265 (INR-1133) DEFLECTING MAGNET FOR ENERGY ANALYSIS OF THE 9.6 MeV PROTON LINEAR ACCELERATOR BEAM. Mekler, Anna (Institute of Nuclear Research, Warsaw (Poland)). 1969. 37p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The symmetric electromagnet, having the capability of deflecting the 9.6 MeV proton beam by an angle ±60° is described. The magnet assures the simultaneous focusing in two perpendicular planes and allows an energy analysis with the accuracy of 25 keV. The magnet is excited from the three-phase full ware rectifier incorporating three silicon diodes and three transistors. The rectifier of nominal power of 7.5 kW has the current regulation range of 10 to 45 A that assures the excitation of a magnetic field in the range of 3000 to 9500 G. The current stabilization circuit consists of two loops of regulation and assures the stability of 1×10^{-4}. The efficiency of the stabilization system at maximum output is 89%. (auth)

20266 (INR-1134) THE CONSTRUCTION OF THE ION SOURCE POWER SUPPLY SYSTEM FOR THE VAN DE GRAAFF ACCELERATOR "LECH." Kacprzak, Z.; Zemlo, L. (Institute of Nuclear Research, Warsaw (Poland)). 1969. 29p. (In Polish). Dep. CFSTI (U. S. Sales Only).

The construction of the power supply system for the ion source, ion focusing and the belt discharging system is described. Also, the control system of the apparatus built inside the high potential terminal is described. Special attention was paid to the reliability of the apparatus because the whole system works at the high potential terminal of the accelerator under the gas pressure of 16 atm. at most. (auth)

20267 (JAERI-1184, pp 1-5) TOPICS ON THE TANDEM ACCELERATOR. Tsukada, Kineo (Japan Atomic Energy Research Inst., Tokyo). (In Japanese).

Recent development of the large tandem accelerator and prospective research on the heavy ion reactions are described together with plans of some tandem laboratories including JAERI's. (auth)

20268 (JAERI-1184, pp 7-10) CONTROL OF BEAM TRANSPORT SYSTEM. Kumabe, Isao (Kyoto Univ. (Japan)). (In Japanese).

Three new control methods were applied to the beam transport system of the tandem laboratory in Kyoto University and are being used successfully, including a beam position indicator and stabilizer in a scattering chamber, a simple control method of beam transport system, and the biased quadrupole: a method of steering accelerator beams. (auth)

20269 (JAERI-1184, pp 11-17) CHARGE EXCHANGE STUDIES OF TANDEM ACCELERATORS. Tawara, Hyroyuki (Kyushu Univ., Fukuoka (Japan)). (In Japanese).

Some recent results on the charge exchange studies with tandem accelerators are reviewed. The charge exchange of low energy helium ions in various alkali vapors has recently aroused interests for the production of intense negative helium ion and an example of the negative helium ion sources with lithium vapor electron adder is shown. In the charge distribution in the equilibrium of high energy heavy ions, the shell effect and the target density effect are observed. The multiple acceleration system of heavy ions with tandem accelerators, based on the target density effect in the charge distribution, is discussed. (27 references.) (auth)

20270 (KFK-1087) ACCELERATION OF DEUTERONS IN A 60-GeV PROTON SYNCHROTRON. Heinz, W.; Pilkuhn, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Nov 1969. 24p. (In German). Dep. CFSTI (U. S. Sales Only).

The Karlsruhe accelerator study group has proposed to build a 60 GeV separated function synchrotron. Possible experiments with accelerated deuterons are discussed, and several alternatives for deuteron acceleration in the proposed machine are considered. It was found that practically without extra cost 10^{12} d/pulse can be accelerated. An improved version can deliver about 10^{13} d/pulse. (auth)

20271 (LNF-68/80) ACTIVITIES OF THE NATIONAL LABORATORY AT FRASCATI FROM 1 JULY 1967–30 JUNE 1968. Note No. 19. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Dec 1968. 27p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The main research activity of the laboratory is summarized. Experiments at the electron synchrotron are discussed including radiochemical research, photodisintegration of ^3He, η^0 photoproduction on H_2, D_2 and other nuclei, π^- photoproduction on neutrons in deuterium, double charge photoproduction on protons, π^0 photoproduction by polarized γ rays beam, wide angle bremsstrahlung, and pion electroproduction near threshold. Experimental apparatus for experiments at Adone have been assembled, tested with cosmic rays, and synchrotron beams, and preliminary tests of background radiations have been performed in Adone with

a single accumulated beam. The "pion hall" with the counting and control halls has been completed. Most of the shieldings in the pion hall has been completed in agreement with the background measurements. The experimental apparatus for elastic and anelastic scattering of pions on nuclei has been performed and is near to be tested on the pion beam. The apparatus for experiments with visual techniques (diffusion chambers) and with activity measurements on residual nuclei is now getting assembled. The construction of a 12 MeV microtron (40-50 mA peak current) with relative injection optics (to be used as injector for the electronsynchrotron) is discussed. Other researches connected with the structure of matter such as researches on liquid He physics have been continued and interesting studies in the field of superconductivity are carried out. Theoretical studies are briefly described. (auth)

20272 (NP-18091) ANNUAL REPORT, 1968. (Tokyo Univ. (Japan). Inst. for Nuclear Study). 104p. Dep. CFSTI (U. S. Sales Only).

ALUMINUM-27—alpha elastic scattering at 38 MeV, angular distributions for, (E)
BARIUM-138—proton reactions (p,d) at 52 MeV, angular distributions for, (E)
CADMIUM-112—proton reactions (p,t) at 52 MeV, angular distributions for, (E)
CADMIUM-114—proton reactions (p,t) at 52 MeV, angular distributions for, (E)
CADMIUM-116—proton reactions (p,t) at 52 MeV, angular distributions for, (E)
CALCIUM-40—energy levels from calcium-42 (p,t) reactions, (E)
CALCIUM-42—proton reactions (p,t) at 52 MeV, angular distributions for, (E)
COSMIC PARTICLES—reactions with carbon and lead in nuclear emulsion chamber
COSMIC RAY TELESCOPES—operation of multiple detector, for cosmic shower studies
CYCLOTRONS—development of Tokyo Univ. fixed-field
—research at Tokyo Univ. fixed-field
—development of Tokyo Univ. AVF
INSTRUMENTS—development at Tokyo Univ.
MAGNESIUM-26—alpha elastic scattering at 38 MeV, angular distributions for, (E)
MOLYBDENUM-92—proton reactions (p,γ) at 5 to 13 MeV, isomeric cross section ratio for, (E)
—proton reactions (p,t) at 52 MeV, angular distributions for, (E)
NEODYMIUM-142—proton reactions (p,t) at 52 MeV, angular distributions for, (E)
—proton reactions (p,d) at 52 MeV, angular distributions for, (E)
NUCLEAR EMULSIONS—design and use of multiple sandwich, for cosmic ray detection
PHOTONS—interactions $\gamma + n \rightarrow \pi^0 + n$ at 500 to 900 MeV, Cherenkov detector–spark chamber study of amplitudes for
—interactions $\gamma + p \rightarrow K^+ + \Lambda^0$ at 1.06 to 1.16 GeV, Λ^0 polarization in, (E)
PROTONS—interaction p + p at 48 MeV using polarized beams, spin correlation parameters for, (E)
RUBIDIUM-83—energy level at 5 keV from strontium-83 decay, lifetime of, (E)
SILICON-28—alpha elastic scattering at 38 MeV, angular distribution for, (E)
—alpha inelastic scattering at 38 MeV, angular distributions for, (E)
—proton inelastic scattering at 15 MeV, angular distributions for, (E)
—energy levels from silicon-30 (p,t) reactions, (E)
SILICON-29—alpha elastic scattering at 38 MeV, angular distribution for, (E)
—alpha inelastic scattering at 38 MeV, angular distributions for, (E)
—proton inelastic scattering at 15 MeV, angular distribution for, (E)
SILICON-30—alpha elastic scattering at 38 MeV, angular distribution for, (E)
—proton reactions (p,t) at 52 MeV, angular distributions for, (E)
SYNCHROCYCLOTRONS—development of Tokyo Univ.
—research at Tokyo Univ.
SYNCHROTRONS—development and operation of INS Tokyo 1.3-GeV electron
—development of proposed Japanese 8-GeV proton
TUNGSTEN-182—deuteron reactions (d,p) with, angular distributions for, (E)
TUNGSTEN-183—deuteron reactions (d,p) with, angular distributions for, (E)
TUNGSTEN-184—energy levels from tungsten-183 (d,p) reactions, (E)

20273 (TRI-69-8) CONCEPTUAL DESIGN STUDY FOR THE TRIUMF CONTROL AND SAFETY SYSTEM. (TRI-Univ. Meson Facility, Vancouver (British Columbia)). Dec 1969. 83p. Dep. CFSTI (U. S. Sales Only).

A general philosophy for the control of the TRIUMF facility is presented. The hard-wired personnel safety system is based on a system of controlled access areas. Radiation levels throughout the facility are routed through area safety units to central control. Violation of a personnel interlock results in interruption of the beam delivery to the entire facility. A change in radiation levels beyond prescribed limits will also interrupt beam delivery. The machine safety system is based on beam characteristics. Both relative and absolute beam intensity limits are proposed. A beam shut-off time of about 300 μsec is adequate for machine protection, while personnel protection requires the shortest possible beam shut-off time. A computer-based scanning and digitizing system permitting fast and flexible data processing is proposed for the ion source and injection system. The radio frequency will be a fixed reference to which the main magnet field is controlled. The main magnet is regulated by a current shunt and/or an NMR probe. Trim and harmonic coils are current regulated. A scanning system monitors temperatures by measuring the coil voltages and currents and calculating the coil resistance. Beam diagnostics probes will be mounted at 90° intervals. Two probes will measure beam current and two will be shadow probes. High energy beam transport optics will be set using one-word memories at power supplies. A slow scanning system will be used to log optics parameters. Diagnostic devices which are proposed include position, profile, and intensity monitors. Computer control which is redundant in CPU and 1/0 capability has been proposed. Operator communication with devices will proceed through the central computer using CRT-keyboard-shaft-encoder stations. An integrated TV display system using standard TV monitors is proposed. TV camera output, computer graphics and analog signals from diagnostic devices will be handled by the same system. Few, if any, control loops will be closed at commissioning. Data logging will be performed by a digital data acquisition system. Set points will be controlled by an operator using a digital link. As machine development progresses control loops will be closed. (auth)

20274 (TRI-69-10) PHASE SPACE ACCEPTANCE OF A HELICAL QUADRUPOLE CHANNEL OF FINITE LENGTH. Ohnuma, Shoroku (TRI-Univ. Meson Facility, Vancouver (British Columbia)). Oct 1969. 35p. Dep. CFSTI (U. S. Sales Only).

The acceptance region in the four-dimensional phase space of a helical quadrupole channel has been investigated numerically. The two transverse directions are strongly coupled and the projection on the (x,x′) plane of the four-dimensional acceptance region is not independent (y,y′). If such a channel is used as a pion or a muon channel, it has to be matched to quadrupoles and bending magnets so that its effective acceptance would become smaller than the acceptance region in the four-dimensional phase space. In calculating the acceptance, a circular aperture has been assumed. Also, the axial magnetic field B_z is assumed to be small so that the transverse equations of motion are linear. (auth)

20275 (UCRL-18885) LOSSES IN PULSED SUPERCONDUCTING MAGNETS. Gilbert, William S.; Meuser, Robert B.; Voelker, Ferd (California Univ., Berkeley. Lawrence Radiation Lab.). Aug 1969. Contract W-7405-eng-48. 23p. (CONF-690811-15). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

AC, or cyclic, energy losses were determined in a series of geometrically similar solenoids wound with single-core, untwisted-multicore, and twisted-multicore composite superconductor. The twisted-multicore has markedly reduced losses compared with the other alternatives. A larger solenoid was wound with twisted-multicore rectangular conductor. This same type conductor was also used in a dipole (bending) magnet geometry both with and without a cylindrical iron return yoke. Magnetization measurements on multicore composition as a function of mechanical twist rate and magnetic sweep are presented. Theoretical loss of a function of NbTi filament size and maximum swept field are presented. The agreement of the above measurements with theory is discussed. (auth)

20276 ELECTRON RING ACCELERATOR. Montague, B. W. (European Organization for Nuclear Research, Geneva). Phys. Bull. (London); 21: 6-9(Jan 1970).

The basic principles of collective ion acceleration are explained and a particular version, the electron ring accelerator proposed by Veksler (Proc. C.E.R.N. Symp. on High Energy Accelerators and Pion Physics, p 80, 1956, Proc. 6th Int. Conf. on High Energy

Accelerators p. 289, 1967), is described. The present status of work on this machine is summarized. (UK)

20277 ELECTROSTATIC GENERATORS. Allen, W. D. (Bose Research Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta); 31: No. 2, 49-62(Jun 1968).

The design and operation of electrostatic generators are reviewed, and the operation principles and uses of Van de Graaff accelerators are briefly discussed. Also, the Oxford tandem and the Emperor tandem accelerators are described. (W.H.K.)

20278 A BROAD-BEAM BIOLOGY FACILITY FOR PROTON IRRADIATION AT THE OAK RIDGE ISOCHRONOUS CYCLOTRON. Bender, R. S.; Darden, E. B. Jr. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 41: 247-58(Feb 1970).

The broad-beam facility of the Oak Ridge Isochronous Cyclotron was developed primarily for whole-body irradiation of mice with 60-MeV protons. The proton beam is defocused, with the use of three quadrupole lenses and thin scattering foils, to provide a uniform flux over a rectangular exposure field 10 by 12.5 cm. The beam, after leaving the vacuum system, passes through a thin-walled ionization chamber, and the beam charge is measured with a Faraday cup. Output of the ion chamber is a current integrator that can be preset to stop irradiation at the desired absorbed dose, calculated from proton fluence and from range-energy tables. The beam profile is routinely surveyed with a pair of remotely controlled thimble chambers providing a readout of both dose rate and integral output. The chambers are positioned at the edges of the field to monitor operation during exposures. Small fluoroglass dosimeters also are used routinely to measure beam uniformity and range. Entrance-to-exit dose variation is minimized by exposing each mouse in a thin-walled plastic tube rotating broadside to the beam. Up to four mice can be irradiated simultaneously at absorbed dose rates of <50 to >10^4 rads per min. (auth)

20279 REFRIGERATED LIQUID HYDROGEN TARGET SYSTEM (Jun 1969) (Engineering Materials). (Argonne National Lab., Ill.). (CAPE-1967).

2 drawings.

The support system for a commercially available cryogenic refrigerator, which is used with liquid H targets in high energy physics, is described. Standardization of the equipment is possible because of the modular design of the target system. Equipment is packaged in self-contained portable consoles and equipment carts which are easy to maintain, require few spare parts, and can be located in easily accessible areas remote from the experiment site. The system consists of the refrigerator container to which the vacuum jacketed target is attached; the pump, valve, and electrical distribution cart; the compressor; and the control console. (For details see TID-4100 Suppl. 57) (23: 28085) (F.S.)

20280 SOME TECHNICAL ASPECTS OF DESY. Degele, D. (Deutsches Elektronen-Synchrotron, Hamburg). Kerntechnik; 11: 709-16(Dec 1969). (In German and English).

Some important technical developments of the accelerator and of the experiment stations are described, aimed at increased reliability, higher energy and higher intensity. A new generation of experiments could be started by the consistent use of data processing facilities. New particle detectors are also an important part of these developments. (auth)

20281 SOLUTIONS FOR THE MECHANICAL DESIGN OF ISOCHRONOUS CYCLOTRONS. Kuellmer, A.; Dannehl, G. (AEG-Telefunken, Frankfurt am Main). Kerntechnik; 11: 704-9(Dec 1969). (In German and English).

A number of design features and auxiliary devices are described, including a mechanical solution for ease of access to the vacuum space, a slide-in resonator design, and devices for the exchange of ion sources and of targets, all serving to reduce working times spent by the service personnel in the immediate vicinity of the cyclotron. (auth)

20282 ACCELERATION OF VERY HEAVY IONS WITH CYCLOTRONS. Boettger, O. (AEG-Telefunken, Frankfurt am Main). Kerntechnik; 11: 696-703(Dec 1969). (In German and English).

Two cyclotrons, arranged in series, for the purpose of accelerating very heavy ions, are discussed as alternative to the "Unilac" and to the "Helix linear accelerator". Problems in connection with the acceleration of very heavy ions and with series acceleration are discussed, and chances to solve them are indicated. Change of energy and particles are also included, and it is shown that no special designs will be necessary for realization of these changes. The essential advantage of this two-cyclotrons arrangement as compared to other accelerating devices is to be seen in the fact that none but known technologies will have to be used. (auth)

20283 UNILAC, A VARIABLE ENERGY LINEAR ACCELERATOR FOR ATOMIC IONS OF ANY MASS. Angert, N.; Schmelzer, Ch. (Univ., Heidelberg). Kerntechnik; 11: 690-5(Dec 1969). (In German and English).

The interesting and promising possibilities of experiments with fast heavy ions have led to the development of a new generation of accelerators. The project for a high frequency linear accelerator for very heavy ions with which it will be possible to accelerate ions of all the elements of the periodic table up to energies of at least 7 MeV per nucleon is described. (auth)

20284 LOW ENERGY ACCELERATORS. Kleinheins, P. (Staatliche Ingenieurschule, Esslingen, Ger.). Kerntechnik; 11: 683-90(Dec 1969). (In German and English).

Small, compact accelerators for electrons and ions with energies from 100 to 600 keV are being used increasingly in industrial research and production for the investigation and up-grading of materials. A review of the uses and designs of electron accelerators and neutron generators is presented. (15 references) (auth)

20285 CALCULATION OF PARAMETERS FOR MONOCHROMATIZATION SCHEMES OF EXTERNAL CYCLOTRON BEAM. Basargin, Yu. G. (Inst. of High Temperature, Moscow). Zh. Tekh. Fiz.; 39: 2247-51(Dec 1969). (In Russian).

Isochronous cyclotrons with regulated energy possess an external beam energy non-homogeneity of about $\pm 2 \times 10^{-3}$ at ion cluster phase widths of 7 to 40°. In neutron time-of-flight studies a narrow phase band is demanded. An attempt was made to achieve a considerable reduction of cyclotron beam energy straggling by a method used previously with linear accelerators. Two variations were designed. With the first scheme it was possible to anticipate tenfold reduction of the energy straggling in the case in which the initial phase width of the beam was equal to 6° and the cluster centers for various energy particles shift on the L length from the accelerator ±40°. The second scheme was calculated for monochromatization of 100 MeV proton beams. The problem of monochromatization of the external cyclotron beam was resolved with the order of error of $\pm 2 \times 10^{-4}$ in the case in which the phase width of the cluster at the cyclotron exit, did not exceed 5°. (R.V.J)

20286 CALCULATIONS ON A SYSTEM FOR SHAPING NONMONOCHROMATIC CHARGED-PARTICLE BEAMS UTILIZING GENERALIZED AMPLITUDES AND PHASE FUNCTIONS. Grigor'ev, Yu. N.; Petrenko, V. V. (Inst. of Physics and Tech., Kharkov). Zh. Tekh. Fiz.; 39: 2154-7(Dec 1969). (In Russian).

Formation and transportation of nonmonochromatic charged particle beams were measured in the linear approximation. Formulas were obtained for confined particle beams presented in elliptical form on a phase plane. Formulas were also obtained for calculating non-periodic systems of formation and transportation which contains elements of the first order dispersion along the energy. Formulas obtained can be used for optimum selection of parameters of formation and transportation systems using electronic computers. (tr-auth)

20287 OPTICAL CHARACTERISTICS OF THE BEAM FROM AN ELECTRON LINEAR ACCELERATOR. Dem'yanenko, G. K.; Ryabka, P. M. (Inst. of Physics and Tech., Kharkov). Zh. Tekh. Fiz.; 39: 2150-3(Dec 1969). (In Russian).

Data are given on determination of the horizontal and vertical emittance from the current in a transverse section of a beam and of the drift-magnitude in a beam charge center at the exit of a 300-MeV linear electron accelerator. (tr-auth)

20288 CHARGED PARTICLE GENERATOR WITH ELECTROMAGNETIC CURRENT CONTROL. (to United Aircraft Corp.). British Patent 1,183,751. 11 Mar 1970. Priority date 30 Mar 1966, United States.

A hollow-cathode gas discharge ion source which controls the magnitude of the current in the beam of charged particles produced from the plasma generated in the internal cavity of the hollow cathode by means of a controlled magnetic field acting on the plasma is described. (W.H.K.)

20289 VACUUM SYSTEM OF THE SIN RING ACCELERATOR. Frei, H. (Schweizerisches Institut fuer Nuklearforschung, Zurich. Vortrag der Vakuumtagung, Basel). Vakuum-Tech., 18: 127-30(Jul 1969). (In German).

The requirements for the high vacuum are predominantly dictated by the conditions of large RF-cavities. Tests for achieving high RF voltages have shown the necessity of an oil free vacuum which is being maintained by the use of turbo-molecular and sputter ion pumps. The problem of vacuum seals in the ring chamber, consisting of single sectors, are solved by pneumatic sealing flanges. After consideration of the gas sources two possible vacuum systems for the accelerator are discussed: large Titanium

sublimators together with sputter ion pumps and, also, Cryo surfaces of 20°K. (auth)

20290 MULTICHARGED Ca AND Zn ION SOURCE. Pasyuk, A. S.; Vorob'ev, E. D.; Ivannikov, R. I.; Kuznetsov, V. I.; Kutner, V. B.; Tret'yakov, Yu. P. At. Energ. (USSR); 28: 75-8(Jan 1970). (In Russian).

Descriptions are given of the design and performance of multicharged ion source. The source was used with calcium and zinc metal with the vapor elasticity reached at about 800 to 900°C. The multicharged calcium and zinc ions were obtained with a source developed for the U-300 cyclotron. Tabulated data indicate pulsed current values for nine-charged calcium ions and ten-charged zinc ions. In such a case the mean zinc consumption is ~50 mg/hr and calcium consumption is ~100 mg/hr. Experiments on acceleration of hepta-charged calcium ions and deca-charged zinc ion showed a mean current for Ca_{7}^{7+} ions on the 100 cm radius reached 3 μA and an extracted deco-charged zinc beam up to $\approx 10^{-4}$ μA. (R.V.J.)

20291 POSITION MONITORING SYSTEM FOR A PULSE-MODULATED CHARGED PARTICLE BEAM. Johnston, Lawrence H.; Pierce, William B. (to United States Atomic Energy Commission). U. S. Patent 3,496,463. 17 Feb 1970.

A beam position monitoring system is described. The system includes an inductive pickup made of an electrically conductive tubular section with portions removed so as to leave four longitudinal plates to be positioned parallel to the path of the beam and connected as two single-turn orthogonal loops with central axes coincident with the central path of the beam, and an inverse gain circuit for normalizing output signals from respective loops to be proportional only to the beam position with respect to the central path. (AEC)

20292 ACCELERATION OF FISSION FRAGMENTS. Cheifetz, E. (Univ. of California, Berkeley); Gatti, R. C.; Jared, R. C.; Thompson, S. G.; Wittkower, A. Phys. Rev. Lett.; 24: 148-52 (26 Jan 1970).

Fission fragments produced by the isotope ^{252}Cf were accelerated to energies of ~200 MeV using a model MP Van de Graaff accelerator. The fragment-energy spectra were measured as a function of accelerator voltage. Some information was obtained on the average charges of the fragments. Estimates are given of the energies which could be attained by fragments if much higher acceleration voltages are used. (auth)

20293 REDUCTION OF THE RESIDUAL PHOTON DOSE RATE AROUND HIGH-ENERGY PROTON ACCELERATORS. Armstrong, T. W. (Oak Ridge National Lab., Tenn.); Barish, J. Nucl. Sci. Eng.; 40: 129-32(Apr 1970).

The potential radiation hazards around high-energy proton accelerators due to the radiation level in the accelerator tunnel after the beam has been shut off is studied. The effectiveness of reducing the photon dose rate in the tunnel by decreasing the low-energy neutron flux in the concrete is calculated. Three methods for lowering the neutron flux are considered: the addition of boron to the concrete, the addition of a layer of boron to the surface of the concrete, and the addition of a layer of cadmium to the surface of the concrete. The calculations were carried out using Monte Carlo methods. Results are presented graphically and were obtained using concrete with 1.0% sodium content. (W.H.K.)

20294 SHIMADZU 20 MeV MEDICAL BETATRON. Toriyama, Hideaki; Hattori, Hiroyuki; Maruo, Kazuyoshi (Shimadzu Seisakusho Ltd., Kyoto). Shimazu Hyoron; 26: 411-15(Dec 1969). (In Japanese).

The Shimadzu 20 MeV Medical Betatron, exclusively designed for electron therapy, is described. The apparatus is an improved model of the 26 and 32 MeV betatrons; the improvement was mainly aimed at compactness, light weight, and simplicity of operation. In spite of its small size and light weight, it ensures a high radiation output of 1300 R/min at 60 cm (F.S.D.) for electron beams. The first machine was installed at the Sapporo National Hospital, Hokkaido, Japan, in March 1969. (auth) (NSA of Japan)

20295 UNSYMMETRIC ELECTRON GUN FOR PRODUCING HELICAL BEAM. Korolev, F. A.; Kurin, A. F. Vestn. Mosk. Univ., Ser. III, Fiz. Astron.; No. 5, 116-18(Sep-Oct 1969). (In Russian).

The problem of well-twisted helical electron beam in a magnetic field with as small as possible dispersion along the longitudinal velocities in the areas of interactions with high frequency waveguides or resonators was studied. Descriptions are given of the design and performance of a simple gun used in experiments inducing oscillations in a Fabry-Perot type resonator by electrons rotating in a constant magnetic field. (R.V.J.)

20296 PARTICLE ACCELERATORS: A BRIEF HISTORY. Livingston, M. Stanley. Cambridge, Mass.; Harvard University Press (1969). 127p. $6.95.

Topics include the race for high voltage, Ernest Lawrence and the cyclotron—an anecdotal account, synchronous accelerators and how they grew, the story of alternating-gradient focusing, origins of the Cambridge Electron Accelerator, the 200-GeV accelerator, and chronology of development of particle accelerators. (W.H.K.)

20297 SINKHROTRON TPI NA 1,5 GeV. (The 1.5 Gev Synchrotron of Tomsk Polytechnic Institute). Vorob'ev, A. A.; Chuchalin, I. P.; Vlasov, A. G.; Kuz'min, V. N.; Sipailov, G. A.; Solntsev, B. A.; Fomenko, G. P.; Shchanin, P. M. Moscow; Atomizdat (1968). 160p.

The Tomsk Polytechnic Institute 1.5-GeV electron synchrotron is described. A brief review is given of the physical aspects and the basic synchrotron parameters. Construction of the magnet, its supply system, magnetic measurements and magnetic field adjustment are discussed in the four chapters. The high-frequency system, the vacuum system, injection system, and the control, interlock, and signaling systems are covered in the last five chapters. The start-up and performance of the accelerator are also discussed. (R.V.J.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 18901, 19961, 20284, 20637, and 20639.

20298 (AD-696226) MEASUREMENT AND ANALYSIS OF THE TRANSPORT OF FAST NEUTRONS IN LIQUID NITROGEN. Final Report. Russell, John I. Jr. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Nov 1968. Contract DASA01-68-C-0124. 282p. (GA-9081; DASA-2218). CFSTI.

The neutron spectrum was measured as a function of distance from a point source of 14-MeV neutrons in a tank of liquid nitrogen. Pulse height data were taken with a 5 inch spherical NE 213 spectrometer. The report describes measurement of the detector response functions and unfolding of the spectra from the pulse height data. (auth) (USGRDR)

20299 (N-70-12216) REEVALUATION AND ANALYSIS OF NEUTRON SPECTRA IN LIQUID HYDROGEN. Final Report. Trimble, G. D.; Selph, W. E. (Gulf General Atomic, Inc., San Diego, Calif.). 4 Aug 1969. Contract NAS3-11228. 283p. (NASA-CR-72598; GA-9480). CFSTI.

Angular neutron spectra were measured from 15 MeV to 0.0005 eV at various angles for liquid hydrogen thicknesses of 2.5, 4.5, 7.0, 10.5, and 13.0-in. Since considerable time had elapsed between the two contracts, it was felt desirable to reevaluate and update all the spectral data in a consistent manner using the latest available techniques. This report describes those methods and techniques used to reevaluate and update all the spectral data generated under the above mentioned contracts. Calculations were performed using Monte Carlo and discrete ordinates codes for comparison with selected spectral measurements. The reevaluated and updated spectral data and calculations are tabulated. (STAR)

20300 (DD) REACTIONS ON A GASEOUS TARGET OF D_2O VAPOR USED AS NEUTRON SOURCES. Debiesse, Jean; Klein, Siegfried; Ngo Van Hai; Oria, Michel; Lepetit, Jacques (Institut National Des Sciences et Techniques Nucleaires, Saclay, France). Compt. Rend., Ser. B; 270: 185-8(12 Jan 1970). (In French).

Fast neutrons were obtained by sending accelerated deuterons from an electrostatic generator on a D_2O vapor target. D_2O molecules are immediately renewed by evaporation, which avoids the depletion occurring with metal targets. (auth) (France)

20301 NEUTRON WAVE ANALYSIS IN FINITE MEDIA. Nishina, K.; Akcasu, A. Z. (Univ. of Michigan, Ann Arbor). Nucl. Sci. Eng.; 39: 170-81(Feb 1970).

Energy-dependent diffusion theory with a modified one-term degenerate kernel is employed to derive an expression for the detector response in neutron-wave experiments performed in a slab and a cylinder of crystalline moderator. The Watson transform and the Laplace transform modified to finite systems are used and different mathematical representations of the detector output are discussed. From the derived expressions, various decaying modes, including the continuum mode, are calculated for a 100-cm graphite slab. The condition for the existence of the discrete mode is studied, and the maximum frequencies obtained are 7440 cps for graphite and 9300 cps for beryllium. The experiment reported by Utsuro et al. is interpreted and the observed interference pattern is reproduced analytically with a slight discrepancy in the resonance frequency. The potential of this experiment for measuring moderator properties is also discussed. (auth)

20302 EXPERIMENTS ON PILE PHYSICS BY MEANS OF TOF NEUTRON DIFFRACTION. Kimura, Motoharu; Sugawara, Masumi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 105-13(Dec 1968). (In Japanese).

Based upon the observation in TOF neutron diffraction experiments, that the diffraction peak decays exponentially with time, the possibility of measuring time-dependent neutron spectra in thermalization processes was examined experimentally. An electron linac was used as the pulse neutron source. Moderators adopted in this experiment were $20 \times 20 \times 20$ cm^3 BeO, $20 \times 20 \times 20$ cm^3, $25 \times 25 \times 7$ cm^3 and $20 \times 20 \times 2$ cm^3 light water. A single crystal of Al $5 \times 3 \times 0.5$ cm in size was used for diffraction of neutrons. Neutron detectors were BF_3 proportional counters. Total flight path length was 9.45 m. Results obtained are shown. Real time dependent neutron spectra were obtained after the corrections for the background, the overlapping of neighboring peak, etc., were made. It was found that the approach to an asymptotic spectrum was slower than expected for the BeO moderator. Further improvement in time resolution is required for measurements in the light water system. (NSA of Japan)

20303 BREMSSTRAHLUNG OF RaD-Be NEUTRON SOURCE. Takahara, Hikaru (Chiba Univ., Japan); Iida, Hiroyoshi. Chiba Daigaku Bunrigakubu Kiyo, Shizenkagaku; 5: 229-30(Nov 1968). (In Japanese).

When the radiation emitted from RaD-Be neutron source was measured with a NaI(Tl) scintillation spectrometer, besides well known 0.0465 MeV radiation, another radiation was observed in lower energy region, therefore this radiation was investigated. For a neutron source of 2.74×10^4 n/sec, 10 mCi of RaD was sheathed in Pt and stainless steel capsules. The change of spectra was investigated when paraffin containing B or Pb was placed as an absorber between source and detector. In examining the spectra of bremsstrahlung which was produced by shielding a RaD source of about 25 μCi with various substances, such as Cu, Ag and Pb, the spectrum of this neutron source agreed with that of the RaD source shielded with Ag plate. Therefore, it can be said that the spectrum of this neutron source is due to the bremsstrahlung of β particle, which is emitted from the neutron source, and stopped by Pt and stainless steel. (NSA of Japan)

20304 PHOTONEUTRON SPECTRA MEASURED BY TIME-OF-FLIGHT METHOD. Mutsuro, Naoshi; Kawamura, Nobuaki (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 57-63(Jun 1969). (In Japanese).

The measurement of energy spectrum and angular distribution of photoneutrons from (γ,n) reaction using the short pulse γ-burst from an electron linac and a 125 m neutron flight tube is described. Test experiments were performed on a time-of-flight analyzer. A 50-MeV electron beam was converted on a Ta target of 1 mm thickness to bremmstrahlung. The over-all resolution of the time-of-flight analyzer was below 5 n.s. Time-to-pulse height conversion was adopted in this system. ^{13}C was used for the calibration of neutron energy. Resonance absorption lines observed at the T-O-F station were shown. The neutron detector was a plastic scintillator of 10 cm thickness, and its detecting efficiency was obtained by measuring the neutron spectrum from the photodisintegration of heavy water. (NSA of Japan)

20305 EXPERIMENTAL NEUTRON THERMALISATION. Egelstaff, P. A.; Poole, N. J. International Series of Monographs in Nuclear Energy, Volume 106. Oxford; Pergamon Press (1969). 408p. 130s.

The scope of this book falls into three main categories:- the basic theory of neutron scattering and the practice of spectrum and scattering measurements, descriptions of the most useful scattering models and results of inelastic scattering measurements of moderators, details of the spectrum measurements that have served to give confidence to these scattering laws. (UK)

20306 COMMENTS ON THE PAPER "NEUTRON DIFFUSION MEASUREMENTS IN WATER FROM 18 TO 280° C." Butland, A. T. D.; Chudley, C. T. J. Phys., D (London); 3: L1-2(Jan 1970).

Three points arise from a recent paper by Bowen and Scott (1969, ibid, Ser. 2, 2, 401) on pulsed neutron measurements in H_2O. The first difficulty arises over the basic formula quoted in the paper, the second concerns the fitting procedure used to obtain D_0, and the third deals with a misconception in the use of the so-called "effective width" model for H_2O. (auth) (UK)

20307 NEUTRON SOURCE WITH VARIABLE YIELD USING A RADIOISOTOPE. Suzuki, Syunichi (to Nippon Electric Co.). Japanese Patent 1969-20159. 30 Aug 1969. Filed 8 Oct 1965.

The neutron source proposed utilizes the (α,n) reaction, using an α-particle emitting isotope and a material ejecting neutrons from irradiation by α-rays. The advantages obtained are the variation in neutron yield, and the virtual suspension of the neutron production when not in use, for example during the source transportation. Semicircular plates with an alpha-particle emitting isotope, and semicircular plates of a material emitting neutrons from α-irradiation, are fixed alternately in a shielding vessel at regular intervals. Semicircular plates of a material to absorb α-particles are set on a rotatable axis. The α-particle absorbing plates are rotated and inserted between the plate of an α-particle emitter and the neutron ejector; thus the emitted α-particles are absorbed according to the extent of insertion. In this way, the rate of neutron production can be varied. Any other arrangement of plates and movement of plates can be utilized likewise. (NSA of Japan)

20308 INITIAL-VALUE PROBLEM FOR NEUTRON TRANSPORT IN A COUPLED CORE ASSEMBLY. Belleni Morante, A. (Univ., Florence). Meccanica; 4: 183-9(Sep 1969).

The existence and the uniqueness of the solution of a simple mathematical model of the neutron transport phenomenon in a system composed of two multiplying cores separated by an absorbing region are proven. Moreover, it is shown that the neutron transport matrix operator has at least one real eigenvalue, and the asymptotic behavior of the neutron density vector as $t \to +\infty$ is investigated. (auth)

20309 COHERENT NEUTRON SCATTERING BY POLYMER SOLUTIONS AT INTERMEDIATE CONCENTRATIONS. Jannink, G. (CEN de Saclay, Gif-sur Yvette, France). J. Polym. Sci., Part B; 7: 865-9(Dec 1969).

The feasibility of coherent neutron scattering studies in polymer solutions was tested. Neutrons of 3.7 Å wavelength were scattered in a 10% concentration of polystyrene in carbon disulfide. The intensities of scattered neutrons were compared with predictions obtained with the theory of polymer solutions at intermediate concentrations. (J.W.R.)

20310 INTEGRAL IDENTITY DUE TO RAMANUJAN WHICH OCCURS IN NEUTRON TRANSPORT THEORY. Dorning, J. J.; Nicolaenko, B.; Thurber, J. K. (Brookhaven National Lab., Upton, N. Y.). J. Math. Mech.; 19: 429-38(Nov 1969).

It is shown the large t asymptotic behavior of a family of functions related by Ramanujan's identity described in the Bateman Manuscript Project is incorrect. (J.W.R.)

20311 INTEGRAL METHODS FOR TWO-DIMENSIONAL NEUTRON TRANSPORT IN SLAB GEOMETRY. Gratt, Lawrence Barry. Los Angeles; Univ. of California (1969). 242p.

Thesis.

The two-dimensional transport problem of a point source of monoenergetic neutrons on the surface of a slab is investigated using integral transform techniques. Approximate solutions of the slab flux are developed based on the existing exact half-space solution using the integral formulation of neutron transport theory. The movement of the source from the surface into the interior of the slab was analyzed, but resulted in greater mathematical difficulties than starting from the basic formulations. Three methods of approximation of the flux from a point source of neutrons on a slab are considered. The first uses a double Fourier transform of the iteration equation, which is solvable by the Wiener–Hopf technique. This method is shown to be applicable to the symmetric problem of a point source in the center of a slab. The second method omits the final transform, complicating the algebra and increasing the number of integrations within the solution. The final method is a constructed solution where semi-infinite results are used to construct the solution of a finite problem. The latter technique represents the most complicated form for generating numerical results. Comparison of these methods indicates that the first one is the most suitable for numerical work. (Diss. Abstr.)

20312 ENERGY-DEPENDENT DIFFUSION THEORY TREATMENT OF NEUTRON WAVE PROPAGATION IN A FINITE MEDIUM. Nishina, Kojiro. Ann Arbor, Mich.; Univ. of Michigan (1969). 181p.

Thesis.

Neutron wave experiments in finite media such as an infinite slab and a finite cylinder of crystalline moderators are investigated. The existing theoretical studies of neutron waves usually consider only the asymptotic solution in infinite media, and attempt to determine certain medium parameters from the relaxation length of this solution. The interpretation of experiments in finite system, however, requires not only the relaxation lengths of the decaying terms in the solution, but also their magnitudes in order that one can determine the relative importance of the discrete wave mode. The complete solution in the above geometries is constructed by means of the Watson transform, and the observed interference phenomenon reported by Utsuro et al., for a graphite cube is interpreted. (Diss. Abstr.)

20313 MEASUREMENT OF THERMAL NEUTRON DECAY PARAMETERS IN WATER USING A SINUSOIDAL SOURCE OF FAST NEUTRONS. Foley, John Edward. Tucson, Ariz.; Univ. of Arizona (1969). 123p.

Thesis.

A time varying source of fast neutrons was used to determine the amplitudes and decay constants of the fundamental and higher spatial modes of the neutron population in a moderating assembly. In the traditional pulsed neutron experiment, the higher spatial modes are difficult to measure as the modes usually have small amplitudes and their decay rates are much faster than the fundamental. By using a sinusoidally varying source of fast neutrons, rather than the fast pulse, it is possible, by increasing the frequency of oscillation, to enhance the amplitudes of the higher spatial modes with respect to the fundamental. The amplitudes and decay constants of the higher modes can then be determined much easier. This method of measuring decay parameters of moderating assemblies has several advantages over the pulsed method. Because a sinusoidal source is used, counting rates are high, whereas in the pulsed method counting rates are low because of the low duty factor of the source. Inaccuracies introduced into the results because of drifting of the electronic counting equipment are minimized as the results are obtained very quickly. Lifetimes a factor of ten shorter than can be measured with the pulsed method are obtainable with the same counting equipment. The reason for this is that the data is spread over many more channels of the multichannel analyzer. (Diss. Abstr.)

20314 STUDIES OF THE TWO-DIMENSIONAL TRANSPORT EQUATION. Sotoodehnia-Korrani, Ahmad. Los Angeles; Univ. of California (1969). 136p.

Thesis.

The two-dimensional time-independent mono-energetic, integro-differential Boltzmann transport equation (BTE), with isotropic scattering is investigated, for different geometrical configurations. These geometries are the full-, half-, and quarter-space and the finite slab. For each case the solutions are obtained in terms of discrete and continuum modes and the correction terms due to the finite boundaries in half- and quarter-space and in slab problems are obtained. The two-dimensional BTE is reduced to a form similar to the one-dimensional transport equation by a Fourier Transformation of the y variable (one of the spatial variables). The elementary solutions for this reduced equation are obtained and the completeness of these solutions is proved by solving a generalized Riemann–Hilbert Problem. These elementary solutions are used to write a general solution whose expansion coefficients are evaluated by the use of orthogonality relations. In the full- and half-space cases these coefficients are obtained in closed form. However, in the case of the finite slab the expansion coefficients are obtained by solving a set of coupled Fredholm integral equations. In the quarter-space problem the expansion coefficients are obtained in a closed form when the surface value of the angular flux is approximated by its half-space value. The half-space problem is also solved by the Wiener–Hopf technique for comparison. Diffusion theory is applied to these geometries, and the results are compared with asymptotic transport theory. It is shown that the two results agree in the limits of diffusion theory for all cases, except for a line source located on the surface of a half-space, however, in this case for very large values of y (B–O) the two solutions tend to agree. (Diss. Abstr.)

20315 COUPLED SAMPLING WITH MONTE CARLO METHOD IN NEUTRON TRANSPORT CALCULATIONS. Carter, Leland LaVelle. Seattle; Univ. of Washington (1969). 181p.

Thesis.

A coupled sampling technique is developed to minimize the total computation time for a given precision in the estimate of a functional, such as a reaction rate, due to a given neutron source distribution. The estimate of the functional is obtained by the Monte Carlo probabilistic simulation through sampling from the adjoint neutron transport equation and the utilization of the energy-dependent reciprocity theorem. The application of the coupled sampling approach is demonstrated in four model problems. The example problems progress in difficulty from the first problem, for an infinite medium with isotropic elastic scattering, to more complex problems involving multi-region, finite media with both anisotropic elastic scattering and inelastic scattering. The application examined in the second problem is for an assembly that is simple enough so that small mesh intervals may be used for the numerical approximation of the theoretical "zero variance" sampling scheme. The last two problems utilize coupled sampling with larger mesh intervals and include both anisotropic elastic scattering and inelastic scattering. The last problem illustrates the use of coupled sampling to compute the neutron flux spectra both within and outside of a critical assembly of plutonium and polystyrene with a hydrogen-to-plutonium atomic ratio of fifteen. The calculations in these model problems are for assemblies of fairly simple geometries so that a one-dimensional discrete-ordinate transport theory calculation is used to obtain the spatial distribution of the fission source for the subsequent Monte Carlo calculation. For multiplying media with more complex geometries that are not amendable to discrete-ordinate techniques, it is necessary to use the Monte Carlo method to obtain the spatial source distribution. An accelerated matrix approach is developed to improve the source convergence rate in Monte Carlo calculations. In an example problem considered, this accelerated matrix approach provides a significant improvement over other source convergence methods because it corrects the Monte Carlo source distribution at each

iteration by utilizing the solution of the matrix equation for the multiplication factor. (Diss. Abstr.)

Nuclear Properties and Reactions, A≤5

Refer also to abstracts 20095 and 20176.

20316 THE ELASTIC SCATTERING OF PROTONS AND DEUTERONS FROM DEUTERIUM: THE REACTIONS $^{2}H(p,p)^{2}H$ AND $^{2}H(d,d)^{2}H$ AND NEUTRON–PROTON COINCIDENCE MEASUREMENTS IN THE REACTION $^{9}Be(p,pn)^{8}Be$. Wilson, Arthur Seymour. Houston, Tex.; Rice Univ. (1969). 181p.

Thesis.

The elastic scattering of protons and deuterons by deuterium was investigated using a tandem Van de Graaff accelerator and a precision small volume gas scattering chamber. For p-d data, excitation curves were taken at 45.28, 90.26, and 118.92° cm for lab proton energies from 4.5 to 11.4 MeV. Angular distributions were taken at 4.45, 5.45, 6.50, 7.46, 8.47, 9.47, 10.47, and 11.47 MeV from 30 to 140° cm. For d-d data, excitation curves were taken at 60 and 90° cm for lab deuteron energies from 3.5 to 12.25 MeV. Angular distributions were taken at 4.46, 5.46, 6.47, 8.51, 9.53, 10.55, and 11.57 MeV from 40 to 97.5° cm. Excitation curves were taken in 20 or 50 keV (lab) steps; angular distributions were taken in 2½ or 4° cm steps. Neither the p-d nor the d-d excitation curves exhibit significant anomalies. Therefore the present data yield no evidence for the existence of excited states in ^{3}He between 8.5 and 13.1 MeV excitation with isospin T = ½ or possibly T = ⅗; nor for the existence of excited states in ^{4}He between 25.55 and 29.66 MeV excitation with isospin T = 0. The reaction $^{9}Be(p,pn)^{8}Be$ was investigated through detecting the outgoing proton and neutron in coincidence. The proton was detected with a solid-state counter, and its energy was determined. The neutron was detected with scintillation counter, in which pulse shape discrimination was employed to differentiate between neutrons and gammas, and the energy of the neutron was determined through its time-of-flight. Low-lying states in ^{9}Be and ^{8}B were successfully identified. Ratios of intensities of these states agree with ratios previously reported in the literature. (Diss. Abstr.)

20317 (N–69–40334) INTERACTION CROSS SECTIONS OF NUCLEONS WITH HELIUM. Barashenkov, V. S.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Translated from report JINR–P2–4333. 4p. (NASA–TT–F–12606). CFSTI.

A theoretical determination of the interaction cross sections between fast nucleons and ^{4}He is made. (auth) (STAR)

20318 OBSERVATION OF CHARGE-ASYMMETRY EFFECTS IN THE REACTION $^{2}H(\alpha,^{3}H)^{3}He$ AT 27.4 MeV c.m. Gross, E. E. (Oak Ridge National Lab., Tenn.); Newman, E.; Roberts, W. J.; Rutkowski, R. W.; Zucker, A. Phys. Rev. Lett.; 24: 473-6(2 Mar 1970).

The differential cross section for the reaction $^{2}H(\alpha,^{3}H)^{3}He$ was measured from 31 to 149° cm with an 82-MeV α-beam. The measurements were made to test the Barshay–Temmer theorem which requires ^{3}H and ^{3}He yields to be independently symmetric about 90° cm. It is found that a pronounced and angle-dependent deviation from 90° symmetry, as large as 10% at some angles, occurs. The results thus constitute the first clear-cut evidence for a violation of the above theorem. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 20063, 20085, 20254, 20316, 20350, 20368, 20443, and 20453.

20319 (AD–695417) ELASTIC ELECTRON SCATTERING EXPERIMENTS WITH ^{15}N. Daily, E. B.; Croissiaux, M. G.; Schweitz, B. (Stanford Univ., Calif. High-Energy Physics Lab.). May 1969. Contract Nonr-225(67). 20p. (HEPL–582). CFSTI.

The nucleus ^{15}N was investigated by the electron scattering technique at incident energies of 250 and 400 MeV. The first diffraction minimum was observed and measured. The data were analyzed by using two nuclear charge density distributions; the Fermi model and the shell model. A value for the radius and skin thickness of the ^{15}N nucleus is given although the data do not fit the diffraction minimum. (auth) (USGRDR)

20320 (JAERI–1184, pp 49–51) COUPLED CHANNEL CALCULATION FOR THE ELASTIC PROTON SCATTERING BY ^{12}C. Mikoshiba, Osamu; Tanifuji, Makoto; Terasawa, Tokuo (Tokyo Univ. (Japan)). (In Japanese).

The elastic scattering of protons by ^{12}C exhibits several intermediate resonances in the energy region of $E_p = 0 \sim 8$ MeV. Analyses of the elastic scattering data were performed in terms of the coupled channel calculation with a realistic generalized optical potential. Some preliminary results and comments on further developments are presented. (auth)

20321 (JAERI–1184, pp 79–82) $(^{3}He,p)$ REACTIONS. Matsuda, Kazuhisa (Institute of Physical and Chemical Research [Saitama, Japan]). (In Japanese).

Experimental results of the reactions, $^{12}C(^{3}He,p)^{14}N$ and $^{27}Al(^{3}He,p)^{29}Si$, are presented. For the former case, the difference between $(^{3}He,p)$ and (α,d) is emphasized, while for the latter the strongly excited groups at the high excitation energy (10 MeV ~ 20 MeV) of ^{29}Si are discussed. The isotopic spin dependence on the two-nucleon transfer reaction is mentioned according to the stripping and pick-up theory. (auth)

20322 SELECTIVE ORBITAL ANGULAR MOMENTUM TRANSFER IN $(^{3}He,t)$ REACTIONS. Schwartz, J. J.; Watson, B. A. (Stanford Univ., Calif.). Phys. Rev. Lett.; 24: 322–4 (16 Feb 1970).

Angular distributions previously found to be characteristic of the spin change for $(^{3}He,t)$ transitions in even-mass $f_{\frac{7}{2}}$-shell nuclei are found to characterize transitions for a number of even- and odd-mass nuclei in the s-d shell. It appears that this may be due to certain strong selectivities in the orbital angular momentum transfer. (auth)

20323 A MEASUREMENT AND ANALYSIS OF THE ELASTIC AND INELASTIC SCATTERING OF 18.4-MeV ALPHA PARTICLES BY ^{19}F NUCLEI. Wiley, Charles Lynn. Lafayette, Ind.; Purdue Univ. (1969). 163p.

Thesis.

The angular distributions to the $^{19}F(\alpha,\alpha')^{19}F^{*}$ reactions leading to the ground and first five excited states in the ^{19}F nucleus were determined at 5° intervals over the range of angles from 15 to 155°, measured in the laboratory frame of reference. The average incident-particle energy at mid-target was 18.40 MeV. The six lowest-lying levels in the ^{19}F nucleus fall into two natural groups, each containing three levels spaced approximately 100 keV apart. Because of this small level spacing, it was necessary to use a broad-range magnetic spectrograph to obtain the high resolution required for this experiment. The experimental differential cross sections corresponding to the $^{19}F(\alpha,\alpha')^{19}F^{*}$ reactions were determined to within an overall accuracy of ±(10–15)%. The differential cross sections corresponding to inelastic-scattering-induced transitions to the $\frac{1}{2}^{-}$ state at 0.10987 MeV are too small to be measured in this experiment, and those corresponding to transitions to the $\frac{5}{2}^{-}$ state at 1.3466 MeV were of poor quality due to the paucity of the data. With the exception of the two angular distributions just mentioned, the experimental differential cross sections exhibit diffraction-like patterns with large-amplitude oscillations in the forward hemisphere, while in the backward hemisphere, the oscillatory structure is irregular and somewhat washed out. These angular distributions generally agree with the predictions of the Blair phase rule. The elastic-scattering data were analyzed within the framework of a four-parameter optical-model potential. The results of this analysis indicate that reasonable representations of the experimental data can be obtained for either a volume-absorption or a surface-absorption imaginary well in the optical-model potential, although the agreement with the experimental data is better for the differential cross sections calculated on the basis of a volume-absorption potential. The best overall fits to the experimental data were achieved using deep (e.g., ≈ 175 MeV) real potential wells. Using two different models for the inelastic-scattering reaction mechanism, the inelastic-scattering data were analyzed within the framework of DWBA calculations based on a volume-absorption optical-model potential. The first DWBA analysis was performed on the basis of the collective-excitation model, assuming the ^{19}F nucleus to have a static quadrupole deformation. The second DWBA analysis was based on the bound-cluster-excitation model in which the ^{19}F nucleus was assumed to consist of either a ^{3}H cluster bound to an ^{16}O core or a ^{4}He cluster bound to a ^{15}N core. In all of the DWBA analyses, again with the exception of those pertaining to transitions to the $\frac{1}{2}^{-}$ state at 0.10987 MeV and the $\frac{5}{2}^{-}$ state at 1.3466 MeV, the best agreement between the experimental and the theoretical differential cross sections was obtained when shallow optical-model potentials were used to generate the distorted waves. (Disser. Abstr.)

20324 STUDY OF ATOMIC NUCLEUS BY ELECTRON SCATTERING. Torizuka, Yoshiharu; Kimura, Motoharu (Tohoku

Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 1-29(Jun 1969). (In Japanese).

The study of atomic nuclei by electron scattering was extended to ^{9}Be, ^{12}C, ^{16}O, ^{46}Ti and ^{60}Ni. From inelastic scattering experiment, the form factor of 14.1-MeV level of ^{12}C was measured. The form factor of the 16.11-MeV level of ^{12}C was measured and separated into longitudinal and transverse components. An electron scattering experiment in giant resonance region of ^{12}C was performed, choosing the angle to which the longitudinal or the transverse component of form factor contributes mainly. The result was compared with the model of Kamimura et al. which takes account of coupling giant resonance with surface oscillation. Experiment was also made of ^{40}Ca and the result was compared with the particle-hole model. It was shown that the isobaric spin T is a good quantum number contrary to the calculation by Gillet. Electron scattering experiment on ^{60}Ni was also performed and the result was compared with the calculation by Auerbach and Cohen et al. (NSA of Japan)

20325 NUCLEAR REACTIONS WITH ELECTRON BEAMS BY STACKED FOIL METHOD. Nakata, Akira; Ito, Kohei (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 1, 26-32(1968). (In Japanese).

The multipole mode of the photon absorbed by a nucleus in giant resonance region was determined by stacked foil method. An electron beam of 20 to 60 MeV was used. Carbon, copper and tantalum were used as targets. In case of carbon, the target was composed of three sheets of foils, polyethylene + tantalum + polyethylene. The β^{+} spectrum with half-life period of 20 min from ^{11}C produced in the reaction ^{12}C(γ,n)^{11}C was measured. The absorption mode of E1(85%) + E2(15%) was concluded. In the case of copper, the mode of E1(85%) + E2(15%) was concluded. Four sheets of natural copper foil were used as the target. The multipole mode of the absorbed photon in the reaction ^{181}Ta(γ,n)^{180}Ta was concluded to be E1(70%) + E2(30%), and that in the reaction ^{181}Ta (γ,3n)^{178}Ta was mainly E2 mode. The correction for nuclear size was the simple Born factor, and the analytical theory itself requires further discussion. (NSA of Japan)

20326 STUDY OF (d,n) REACTIONS BY RECOIL SPECTROMETRY. Gangadharan, Subrahmanya. Pittsburgh; Univ. of Pittsburgh (1969). 76p.

Thesis.

The reactions ^{6}Li(d,n)^{7}Be (g.s. + 0.431 MeV) and ^{12}C(d,n)^{13}N (g.s.) were studied by recoil spectrometry at bombarding energies of 12, 15, and 17 MeV. The recoils are detected by a solid state detector in coincidence with neutrons which are detected by a plastic scintillator. Experimental absolute differential cross sections at the three bombarding energies for both the reactions are given; also given are the excitation functions over the energy region 12 to 17 MeV at about 60° (recoil cm) for both reactions, and for the reaction ^{19}F(d,n)^{20}Ne (g.s.). The reactions with ^{6}Li and ^{12}C were analyzed by the distorted wave Born approximation, using the code JULIE. The effects of spin orbit force and finite-range and non-locality corrections are investigated and taken into account for comparison with the experiment. The agreement between the experimental and theoretical angular distributions is good for the reactions with ^{6}Li and the agreement for the reaction with ^{12}C is quite fair at 17 MeV. The excitation functions for the two reactions are relatively smooth. The experimental absolute differential cross sections for the reactions with ^{6}Li agree fairly well with the theoretical cross sections obtained by incorporating the spectroscopic factors from recent shell model calculations. For the reaction with ^{12}C, the spectroscopic factor extracted from the experimental cross section agrees well with the theoretical value at 17 MeV. The experimental cross sections at 12 and 15 MeV are higher than the theoretical estimates; some possible explanations are discussed. The ratios of the experimental to theoretical cross sections as a function of bombarding energy follow the same trend as for the reaction ^{12}C(d,p)^{13}C (g.s.). An evaluation of the technique of recoil spectrometry for studying nuclear reactions, (d,n) in particular, is given. (Disser. Abstr.)

20327 THE STUDY OF ^{19}F(d,α)^{17}O REACTIONS AT DEUTERON ENERGIES OF 1.00 TO 2.52 MeV. Hood, Richard Fred. Lexington, Ky.; Univ. of Kentucky (1966). 79p.

Thesis.

The nuclear reactions ^{19}F(d,α)^{17}O were experimentally studied with deuteron energies of 1.00 to 2.52 MeV. Differential cross sections from 30 to 165° are presented for deuteron energies of 1.00, 1.50, 1.75, 2.01, 2.26, 2.37 and 2.52 MeV for alpha particles leaving ^{17}O in the ground state and the first three excited states. Excitation functions are presented for deuteron energies over the entire range at laboratory angles of 86 and 165°. These excitation functions exhibit broad resonance-like anomalies. Total cross sections are presented for energies where differential cross sections were obtained. The angular distributions were fitted to a Legendre polynomial series. The coefficients were found by the method of weighted least squares. (Diss. Abstr.)

20328 PROTON-INDUCED CHARGED-PARTICLE REACTIONS ON ^{14}N AT 46 MeV. Hokhikian, Hagop. Los Angeles; Univ. of Southern California (1969). 142p.

Thesis.

Charged particle reactions resulting from the bombardment of natural nitrogen gas were studied at an incident proton energy of 46 MeV. The emerging deuterons, tritons, ^{3}He, and ^{4}He particles were detected by a ΔE-E counter telescope, consisting of a 250 μ totally depleted surface barrier (ΔE) detector and two lithium drifted silicon (E) detectors in parallel. Elastically scattered protons were detected by a NaI(Tl) detector. The experimental data were analyzed by DWBA calculations including the non-locality and finite range effects in the local energy approximation. The cutoff radius was set equal to zero. A derivative Woods-Saxon form was used for the imaginary part of the potential. Spectroscopic factors were extracted by comparing the experimental and theoretical cross sections near the first minimum and the results were compatible with theoretical predictions. The experiment showed that at 46 MeV incident proton energy a direct reaction mechanism predominates. Several different exit channels are available at this energy and this permits extensive studies of nuclei and nuclear states not accessible to other modes of investigation. (Diss. Abstr.)

20329 (γ,p) TEST EXPERIMENT. Syoda, Katsufusa (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 1, 12-17(1968). (In Japanese).

A (γ,p) test experiment was performed with a broad range spectrometer. Gamma rays were obtained by the bremsstrahlung produced by an electron beam. Adjustment of the spectrometer and the multi solid-state detector system, and shielding of background radiation were the main aims of the experiment. The characteristics of the spectrometer were measured with Am-α source of 7 mm ϕ set at the target position. The resolution ΔE/E was 1-2%. The smaller the size of the source, the better resolution will be obtained. The neutron background produced at the radiator, etc, was greatly reduced by additional paraffin shield containing boron, thus the beam intensity of several tens of μA was enough for the experiment. Photoprotons from ^{12}C, ^{140}Ce and ^{88}Sr were measured, and the measurement for ^{12}C showed good agreement with the previous data. The proton energy distribution from ^{88}Sr was measured, and the maximum proton yield occurred at $E_{P_{max}} \approx$ 6 MeV. An (e,e',p) experiment with ^{90}Zr was also attempted. (NSA of Japan)

20330 ELECTROEXCITATION OF THE LOW-LYING STATES OF ^{16}O. Bergstrom, J. C. (Massachusetts Inst. of Tech., Cambridge); Bertozzi, W.; Kowalski, S.; Maruyama, X. K.; Lightbody, J. W.; Fivozinsky, S. P.; Penner, S. Phys. Rev. Lett.; 24: 152-5(26 Jan 1970).

Measurements are reported of form factors for the electroexcitation of the 0^{+} (6.052-MeV), 3^{-} (6.131-MeV), 2^{+} (6.916-MeV), and 1^{-} (7.115-MeV) states of ^{16}O, in the momentum-transfer region 0.5 to 1.0 fm^{-1}. The data are compared with the predictions of various particle-hole shell models and a two-component phenomenological model. (auth)

20331 STUDY OF ATOMIC NUCLEUS WITH ELECTRON BEAM. Torizuka, Yoshiharu; Kimura, Motoharu (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 1, 1-11(1968). (In Japanese).

High intensity linacs have been used lately for the study of nuclear energy levels by electron scattering. The results of preliminary experiment with an electron linac are reported. Low lying states of ^{12}C, ^{16}O, ^{58}Ni and ^{60}Ni were examined and the obtained results were compared with the previously published data. The form factor for 10.8-MeV level of ^{12}C, which should be of E1 transition was shown as of E3 transition, and the explanation of this effect was given. The analysis of inelastic electron scattering from ^{58}Ni showed the possibility of separation of many levels from the 2^{+} first excited state up to the energy level of 7 MeV. (NSA of Japan)

20332 STUDY OF ATOMIC NUCLEI BY ELECTRON SCATTERING. Torizuka, Yoshiharu; Kimura, Motoharu (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 1-36(Dec 1968).

The study of atomic nuclei by electron scattering was made with an electron linac. The nuclei investigated were ^{9}Be, ^{12}C, ^{16}O, ^{46}Ti, ^{58}Ni and ^{60}Ni. The angular distribution of inelastic electron scattering from 14.4-MeV state of ^{9}Be was measured. The form factors of this transition for the longitudinal part and for the transverse part were separated. For ^{12}C, the form factor of the 14.1-MeV

state was measured. For ^{16}O, it was ascertained that the form factor of 7.2-MeV state (1^-, T = 0) was analogous to the E 3 type observed in the 10.8-MeV state (1^-, T = 0) of ^{12}C. With ^{48}Ti, the existence of many (thirteen) 3^- states was verified. With ^{58}Ni and ^{60}Ni, splitting of the vibration states of high order was observed. The existence of E 3 or E 4 excited state characterizes the spherical nucleus, and the result of the measurements requires systematic study. (NSA of Japan)

20333 LOW-ENERGY REACTIONS IN LIGHT NUCLEI USING DIRECT INTERACTION THEORY. Allison, James L. Lexington, Ky.; Univ. of Kentucky (1966). 139p.
Thesis.

A program was written in FORTRAN for the IBM 7040 data processing system at the University of Kentucky that will compute differential cross sections using direct interaction theory, with a stripping or pickup model, with optical model wave functions for the incoming and outgoing particles. There are provisions for either surface or volume absorption, and a choice of either zero range approximation or the local energy approximation of finite range effects. The program will vary certain optical model parameters, searching for a fit to the measured cross sections. A list of the program with an explanation of its structure and instructions for its use is included. The program was used to study the $^9Be(d,p)^{10}Be$, $^9Be(d,\alpha_0)^7Li$, $^9Be(d,\alpha_1)^7Li$ reactions in the energy region 0.49 MeV $\leq E_d \leq$ 1.96 MeV and the $^{19}F(d,n_0)^{20}Ne$ and $^{19}F(d,n_1)^{20}Ne$ reactions at 5.601 and 6.065 MeV. There is also shown some preliminary work on $^{19}F(d,\alpha_0)^{17}O$ and $^{19}F(d,\alpha_1)^{17}O$ at 1.502 and 2.261 MeV. The scattering amplitudes generated in the construction of the optical model wave functions may be used in the study of neutron elastic and inelastic scattering. Sample results of this application are shown for ^{40}Ca and ^{51}V. (Diss. Abstr. Int., B)

20334 ELECTROEXCITATION OF THE ^{12}C GIANT RESONANCE. Lightbody, J. W. Jr. (National Bureau of Standards, Washington, D. C.; Univ. of Maryland, College Park); Penner, S. Phys. Rev. Lett.; 24: 274-6(9 Feb 1970).

Electroexcitation of ^{12}C in and above the giant resonance was measured at several angles and incident electron energies in order to obtain transverse and longitudinal reduced matrix elements. Results are presented for a q range of from 0.35 to 0.84 fm^{-1} and for excitation of 22 to 37 MeV. Comparison is made with the recent calculation by de Forest of quasielastic scattering, as well as with earlier particle-hole and liquid-drop-model calculations. (auth)

20335 HEAVY-ION REACTIONS INDUCED BY ^{16}O, ^{18}O, AND ^{19}F IONS. Falk, W. R. (Univ. of Manitoba, Winnipeg); Huber, A.; Matter, U.; Benjamin, R. W.; Marmier, P. Nucl. Phys.; A140: 548-70(1970).

Excitation curves have been determined from γ-ray yield measurements for heavy-ion reactions induced by E_{lab} = 12 to 30 MeV ^{16}O, ^{18}O, and ^{19}F ions incident upon thick targets of ^9Be, ^{10}B, ^{11}B, ^{12}C, and ^{23}Na. The yields of radioactive decay products with half-lives greater than one second were measured; hence a large number of the outgoing reaction channels could be observed. The preponderance of heavy reaction products suggests compound-nucleus formation as the dominant reaction mechanism. Statistical-model calculations with a spin-dependent level density have been performed, in which the nuclear moment of inertia was treated as a parameter. Many of the results can be explained satisfactorily with a nuclear moment of inertia 0.55 to 0.7 of the rigid body value (auth)

20336 A ROTATIONAL MODEL DESCRIPTION OF ^{19}F. Walsh, B. C.; Naqib, I. M. (Oliver Lodge Lab., Liverpool). Nucl. Phys.; A140: 571-6(1970).

Rotational-particle coupling (RPC) model calculations were performed for the positive-parity states of ^{19}F using a deformed oscillator potential (Nilsson) and a deformed Woods–Saxon potential. The energy spectra and spectroscopic factors (for the $^{16}O(^3He,d)^{19}F$ reaction) are very similar for both calculations and in good agreement with experimental values and with recent full intermediate coupling shell-model calculations. (auth)

20337 INVESTIGATION OF STATES IN ^{15}O BY THE $^{14}N(d,n)^{15}O$ REACTION. Ritter, R. C.; Sheldon, Eric; Strang, Michael (Univ. of Virginia, Charlottesville). Nucl. Phys.; A140: 609-24(1970).

Bombardment of a ^{14}N gas target with 2.80, 3.42, 3.82, 4.85, and 5.35 MeV deuterons has given absolute differential cross sections for the $^{14}N(d,n)^{15}O$ reaction. With a combination of pulsed-beam and gamma-associated time-of-flight methods angular distributions of neutrons to seven states in ^{15}O have been measured from 0° to 160° (lab). The results have been analyzed with a combination of DWBA and CN codes to derive l_p values and spectroscopic factors. The l_p values are consistent with the generally accepted correspondence between the ^{15}O states and their mirror states in ^{15}N. The most straightforward interpretation of the spectroscopic factors is that ^{15}O shows a concentration of the p-shell hole strength in two spin-orbit split states, while the s- and d-wave strengths are spread over a large excitation energy region, with considerable strength above 8 MeV. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 18987, 19231, 20063, 20085, 20272, 20321, 20322, 20324, 20325, 20329, 20331–20333, 20382, 20399, 20400, 20404, 20424, and 20453.

20338 (COO–1120-90) LIFETIME MEASUREMENTS FROM THE ANALYSIS OF DOPPLER BROADENED SHAPES. Cockburn, P. M.; Stark, W. J.; Krone, R. W. (Kansas Univ., Lawrence. Nuclear Physics Lab.). [1968]. Contract AT(11-1)-1120. 18p. Dep. CFSTI.

A formalism for the analysis of Doppler broadened γ-ray line shapes observed in (a,bγ) type reactions has been developed in order to measure nuclear lifetimes. The technique, which is generally applicable to lifetime determinations in the range of 5×10^{-15} sec to 10^{-13} sec, has been employed to measure the lifetimes of the levels at 4.43 MeV in ^{12}C and 6.92 MeV in ^{16}O. Results of 65 ± 9 fs and $6.4^{+1.5}_{-1.2}$ fs, respectively, were obtained. (auth)

20339 (COO–1120-91) SPIN ASSIGNMENTS OF STATES IN ^{24}Mg FROM AN ANALYSIS OF DOPPLER BROADENED GAMMA RAYS. Krone, R. W.; Cockburn, P. M.; Stark, W. J. (Kansas Univ., Lawrence. Nuclear Physics Lab.). [1969]. Contract AT(11-1)-1120. 21p. Dep. CFSTI.

The spins of the ^{24}Mg states at 12.74, 12.85, and 12.97 MeV excitation, which are populated in the $^{23}Na(p,\alpha\gamma)^{20}Ne$ reaction, have been determined to be 2^+, 2^-, and 2^-, respectively, from $\alpha-\gamma$ correlation measurements. The correlation is measured simply by observing the 1.63-MeV γ ray at 0° and analyzing the γ-ray line shape in terms of the possible spins of the ^{24}Mg states. (auth)

20340 (JAERI–1184, pp 19-24) NUCLEAR PHYSICS USING THE TANDEM ACCELERATOR IN HEIDELBERG. Nomura, Toru (Tokyo Univ. (Japan)). (In Japanese).

Some of the interesting experiments recently carried out using the tandem accelerator of the Max-Planck-Institut für Kernphysik, Heidelberg were discussed. They are as follows: (1) gamma-rays following heavy-ion bombardment on light nuclei, (2) measurement of static quadrupole moment by Coulomb-excitation, (3) test of T-invariance from compound reactions, and (4) heavy-ion transfer reactions with identical and final states. (auth)

20341 (JAERI–1184, pp 36-8) EXPERIMENTAL RESEARCHES AT RUTGERS. Ogata, Hiroshi (Kyoto Univ. (Japan)). (In Japanese).

A brief description about the tandem Van de Graaff accelerator and the experimental programs at Rutgers is given. As an example, the isospin forbidden ^{32}S + p reaction which was used to locate the T = ½ ground analog of ^{33}P in ^{33}Cl is described. An s-wave resonance, having a width of 125 ± 16 eV, was found at an incident proton energy of 3.371 ± 0.004 MeV (corresponding to $E^* = 5.558$ MeV in ^{33}Cl). (auth)

20342 (JAERI–1184, pp 57-61) A COMMENT ON THE DEUTERON OPTICAL POTENTIAL. Furukawa, Hinako; Kawai, Mitsuji (Tokyo Inst. of Tech. (Japan)). (In Japanese).

The deuteron optical potential recently introduced by Yule and Haeberli and by Robson which has the spin orbit potential with $r_{s,o} < r_0$ is investigated. The optical potentials were used in the DWBA calculations of $^{28}Si(d,p)^{29}Si$, $^{40}Ca(d,p)^{41}Ca$, $^{54}Fe(d,p)^{55}Fe$, $^{56}Fe(p,d)^{55}Fe$ and $^{60}Ni(d,p)^{61}Ni$ cross sections and proton polarizations. Good agreement with the experiment was obtained for the 2p neutron transfer reactions of $^{40}Ca(d,p)^{41}Ca$, $^{54}Fe(d,p)^{55}Fe$ and $^{56}Fe(p,d)^{55}Fe$. On the other hand, the agreement was poor for the 1d neutron transfer process of $^{28}Si(d,p)^{29}Si$, the 2p transitions of $^{60}Ni(d,p)^{61}Ni$ and the 1f transitions of $^{56}Fe(p,d)^{55}Fe$. Discussions are given. (auth)

20343 (JAERI–1184, pp 62-5) NEUTRON DEPOLARIZATION IN THE ELASTIC SCATTERING AND THE SPIN-SPIN INTERACTION. Katori, Kenji (Tokyo Univ. (Japan). Inst. for Solid State Physics). (In Japanese).

In order to investigate the target spin dependent interaction [i.e., $V_{IS}\, I \cdot Sf(r)$] in the optical potential, neutron depolarization in the elastic scattering was measured at E_n = 1.36 MeV for the

non-zero spin targets, ^{27}Al, ^{59}Co, ^{63,65}Cu and ^{209}Bi. The values obtained for the depolarization parameter $D(\theta)$ were 0.59 ± 0.13 at $\theta_2 = 120°$ and 1.13 ± 0.25 at $\theta_2 = 27°$ in ^{59}Co. These observations clearly demonstrate evidence for a spin-spin interaction. The general feature in the angular distribution is similar to the numerical results of Stamp. The mass and target-spin-strength dependence seems not to be found in a spin-spin interaction. But that interaction seems to be strongly dependent on the ground state configuration of an individual nucleus. (auth)

20344 (JAERI–1184, pp 116-19) M1 TRANSITIONS FROM ISOBARIC ANALOGUE STATE AND G-T BETA TRANSITIONS. Sakai, M.; Bertini, R.; Gehringer, C. (Institut de Recherches Nucleaires, Strasbourg (France)).

The high-energy deexcitation gamma-rays from the isobaric analog states induced by ^{55}Mn(p,γ)^{56}Fe reactions were measured by an 85cm^3 coaxial Ge(Li) detector. The M1 matrix elements of the gamma rays were discussed in connection with G-T matrix elements of the beta decay from ^{56}Mn to ^{56}Fe. (auth)

20345 (JAERI–1184, pp 123-5) ANALOG RESONANCE IN THE ^{77}Se(p,p) REACTION. Kato, Seigo (Tohoku Univ., Sendai (Japan)). (In Japanese).

The isobaric analog states of ^{78}Se were observed in ^{78}Br as compound-nucleus resonances. Although only particle states were seen, there remains a possibility of observing pure collective excitation mode. (auth)

20346 (JAERI–1184, pp 126-30) INTERMEDIATE STRUCTURE IN THE ^{24}Mg(d,p)^{25}Mg REACTION. Lee, Sang-Moo (Tohoku Univ., Sendai (Japan)). (In Japanese).

A method of separating experimentally an intermediate structure from the cross section fluctuations is discussed. A possibility of T = 2 Isobaric Analog Resonances in ^{26}Al is proposed for the resonances of ^{24}Mg(d,p)^{25}Mg reaction in the deuteron energy range of 1.5 to 3.0 MeV. (auth)

20347 (JAERI–1184, pp 141-5) REACTION TIME MEASUREMENT BY USING BLOCKING EFFECTS IN SINGLE CRYSTALS. Maruyama, Michio; Tsukada, Kineo; Ozawa, Kunio (Japan Atomic Energy Research Inst., Tokyo); Fujimoto, Fuminori; Komaki, Kenichiro (Tokyo Univ. (Japan)); Mannami, Michihiko; Sakurai, Teruo (Kyoto Univ. (Japan)). (In Japanese).

A new method of reaction time measurement by using blocking effects of energetic charged particles in single crystals is presented. Results of application of this method to ^{28}Si(p,p′)^{28}Si* (1st level, 1.78 MeV) and ^{70}Ge(p,p′)^{70}Ge* (1st level, 1.04 MeV) reactions are discussed and it is concluded that the lifetime of compound system (^{70}Ge + p) is $(1.86 \pm 0.86) \times 10^{-17}$ sec. (auth)

20348 STUDY OF γ RADIATION FROM ^{59}Co(n,γ)^{60}Co REACTION IN A CRYSTAL-DIFFRACTION SPECTROMETER. Smirnov, A. I.; Shaburov, V. A.; Alekseev, V. L.; Kaminker, D. M.; Ryl'nikov, A. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 1270-4 (Aug. 1969). (In Russian).

A cobalt metal disk 75 mm in diameter and 4.5 mm thick was put in a neutron flux of 3.5×10^{12} neutrons per sec per cm^2. Gamma ray energy measurements were carried out by means of a quartz crystal with working planes 1340 and with dimensions $60 \times 70 \times 2$ mm. The width of the receiving slit was 120 μm. The energy resolution was 1×10^{-3} E (keV). For gamma lines measured by means of 3 crystals the final energy values were calculated as the average weighted values of three measurements. The average relative error in determining the energy was 6.5×10^{-5}. The relative intensities were determined with an error of less than 20% in the energy region up to 600 keV, and with an error of 40% above 600 keV. Data on gamma energies and relative intensities are presented and compared with literature values. Level schemes and transitions are discussed. (TTT)

20349 MEASUREMENTS OF THE MEAN LIVES OF SOME EXCITED STATES OF THE ^{36}Ar NUCLEUS BY DOPPLER EFFECT. Thibaud, Jean-Pierre; Aleonard, Marie-Madeleine; Castera, Danielle; Hubert, Phillippe; Leccia, Francis; Mennrath, Pierre (Bordeaux Univ.). Compt. Rend., Ser. B; 270: 115-17 (5 Jan 1970). (In French).

Mean lives of the following excited states: 4,978, 5,171, 5,830, 5,856, 5,897 and 6,837 of the ^{36}Ar nucleus are respectively: τ >1,000 fs, τ >1,000 fs, $\tau = (6 \mp 4)$ fs, $\tau = (840 \pm 300)$ fs, τ >600 fs and $\tau = (300 \mp 140)$ fs. (auth) (France)

20350 14 MeV NEUTRON CROSS-SECTION MEASUREMENTS ON V, Ti, Si, AND F. Crumpton, D. (Univ. of Aston, Birmingham, Eng.). J. Inorg. Nucl. Chem.; 31: 3727-9(Dec 1969).

Absolute neutron activation cross sections were measured at 14.7 MeV for the (n,2n) reaction in ^{19}F and ^{46}Ti, the (n,p) reaction in ^{28}Si, ^{48}Ti, ^{51}V, and the (n,α) reaction in ^{51}V, using the associated-particle method to determine the absolute neutron flux. The following results were obtained: 55 ± 2.5 mb for ^{19}F(n,2n)^{18}F, 39.2 ± 1.8 mb for ^{46}Ti(n,2n)^{45}Ti, 297 ± 14 mb for ^{28}Si(n,p)^{28}Al, 80 ± 4 mb for ^{48}Ti(n,p)^{48}Sc, 35.2 ± 1.6 for ^{51}V(n,p)^{51}Ti, and 21 ± 1.0 mb for ^{51}V(n,α)^{48}Sc. The results are compared to those obtained by other authors in the 14-MeV region. (auth) (UK)

20351 ^{27}Al(γ,π^+)^{27}Mg REACTION BY MEANS OF ACTIVATION METHOD. Saito, Teijiro; Ito, Kohei (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No 2, 56-9(Dec 1968). (In Japanese).

Photoproduction of π-mesons from nuclei was investigated, using the stacked foil method. A target, composed of Ta radiator with 0.5 mm thickness sandwiched by two Al foils with 0.1 mm thickness, was irradiated with a high energy electron beam of 100 to 260 MeV for five minutes, and the activity of the foils was measured using a 4″ × 4″ NaI scintillator. The yield of ^{27}Mg was obtained by measuring the γ-ray of 0.84 MeV and 1.01 MeV. For comparison, a target without Ta radiator was also irradiated, and the yields of ^{27}Mg and ^{24}Na were measured. Yields of ^{27}Mg for the foils on both sides of the radiator were nearly the same when the energy of the incident electron was 100 MeV, suggesting that the yield was due to the reaction ^{27}Al(n,p)^{27}Mg. The yield of ^{27}Mg due to the reaction ^{27}Al(γ,π^+)^{27}Mg was ascertained for higher incident energies of 220 to 260 MeV, when the yield from the foils on both sides of the radiator showed a marked difference. (NSA of Japan)

20352 STUDIES OF PHOTONUCLEAR REACTION BY RESIDUAL NUCLEUS METHOD. Oka, Yoshinaga; Saito, Tatsuya (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 114-21(Jun 1969). (In Japanese).

After the irradiation of Na, Mg, Al, Si, P, S, and Cl by Bremsstrahlung with the maximum energy of 200 to 250 MeV for 1 to 3 hours, the radiation intensity of radioactive product nuclides, ^{24}Na and ^{28}Mg, was measured with a 36cc Ge(Li) detector and a 1026 channel PHA. In irradiating the various targets, the saturation yields (μCi/g) of ^{24}Na and ^{28}Mg were obtained from γ-spectra and are tabulated as relative yield in this report. In order to get the information of spin distribution in nuclear reaction, the isomeric yield ratio was investigated. In the present experiment, Sc, Mn, Br, Se, In, Te, Ce, and Hg targets were irradiated by Bremsstrahlung with maximum energy of 30 to 65 MeV and nuclides under consideration were confirmed by measurement with a Ge(Li) detector and a PHA. The spin and the isomeric yield ratios of product nuclei which were produced from each target nucleus were obtained. Generally, when the spin of the product nucleus is close to that of the target nucleus, the yield of the product nucleus is high. The comparison of the calculated value of spin-dispersion-parameter U with the experimental value was discussed. (NSA of Japan)

20353 $\beta-\gamma$-SPECTROSCOPY OF RELATIVELY SHORT-LIVED NUCLEI. Sugiyama, Kazusuke (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 1, 37-49(1968). (In Japanese).

A test experiment of radioisotope production with an electron linac was performed. The main object was to check the yield of (γ,xn), (γ,pxn) and (γ,2pxn) reactions with bremsstrahlung of 65 MeV max. The adjustment of beam centering and cooling system of the irradiation arrangement was also tested. For the yield check, reactions, $^{121+123}$Sb + 30 MeV $\gamma \rightarrow (\gamma,n) \rightarrow {}^{120}$Sb($T_{\frac{1}{2}}$ = 16 min); ^{48}Ca + 65 MeV $\gamma-(\gamma,pn) \rightarrow {}^{46}$K($T_{\frac{1}{2}}$ = 2 min); and ^{51}V + 65 MeV $\gamma-(\gamma,3n) \rightarrow {}^{48}$V (16 days)$-(\gamma,2pn) \rightarrow {}^{46}$Sc (1.8 day) were chosen. The γ-activity of the produced isotopes was measured with Ge(Li) spectrometer, and the spectra obtained are shown. A 3″ ϕ × 3″ NaI(Tl) scintillator was also used. The yield at 65 MeV was ^{48}V < ^{46}Sc < ^{47}Sc, and at 45 MeV, it was ^{46}Sc < ^{48}V < ^{47}Sc. The decay schemes of these isotopes are discussed. Ge(Li) spectrometer with resolution V < 3 keV is necessary for precise measurements of the spectra. (NSA of Japan)

20354 NUCLEAR REACTIONS BY RESIDUAL NUCLEUS METHOD. Oka, Yoshinaga; Kato, Toyoaki (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 122-25(Dec 1968). (In Japanese).

Multi-particle emission reaction by the irradiation of 30 to 70 MeV bremsstrahlung was studied. The yields of ^{24}Na produced by irradiating Mg, Al, Si, P, S, and Cl, and that of ^{64}Cu produced from Zn, Ga, and Ge decreased exponentially with increasing ΔZ, the disparity in atomic number between each nuclide and its parent nuclide. The yields by charged particle emission reactions, such as (γ,pn), (γ,α), (γ,αn), and (α,αpn), on Zn, Ga, Ge and Tl increased with increasing irradiation energy. The yields of ^{45}Ti, ^{44}Sc, ^{46}Sc, ^{47}Sc, ^{48}Sc, and ^{49}Sc from Ti targets and the yields of ^{48}V, ^{46}Sc, ^{47}Sc, and ^{48}Sc from V targets were investigated. Further-

more, the yields and the energy dependencies of (γ,n), (γ,2n), (γ, 3n), and (γ,4n) reactions on ^{89}Y and ^{141}Pr were examined. (NSA of Japan)

20355 ON THE OBSERVED VARIATION OF NUCLEAR TEMPERATURE WITH BOMBARDING ENERGY IN THE ^{55}Mn(α,n)^{58}Co REACTION. Rao, A. Lakshmana; Rama, Rao, J.; Parthasaradhi, K. (Andhra Univ., Waltair, India). J. Phys., A (London); 3: 70-2(Jan 1970).

The available data on the ^{55}Mn(α,n)^{58}Co reaction are analyzed, the variation of the inverse reaction cross section with neutron energy and the newly proposed theory of the pre-compound particles being taken into account. The estimated revised temperatures are found to be 1.39 ± 0.08, 1.44 ± 0.08 and 1.46 ± 0.08 MeV corresponding to bombarding energies 14, 17 and 20 MeV. Thus it has been found that the nuclear temperature is independent of bombarding energy in the reaction under consideration, unlike the previous investigations. (auth) (UK)

20356 THRESHOLD PHOTONEUTRON CROSS SECTION FOR ^{25}Mg AND ISOBARIC ANALOGS OF ^{25}Na. Berman, B. L.; Baglan, R. J.; Bowman, C. D. (Univ. of California, Livermore). Phys. Rev. Lett.; 24: 319-22(16 Feb 1970).

The photoneutron cross section for ^{25}Mg was measured from 30 to 2000 keV above threshold. The locations of the isobaric analogs of the ground and first excited states of ^{25}Na were assigned and lower limits for their neutron-decay widths were determined. (auth)

20357 THE HALF-LIFE OF ^{38}Cl. Steinnes, E.; Tollan, O. (Institutt for Atomenergi, Kjeller, Norway). Radiochim. Acta; 12: 214-15(Dec 1969).

The half-life of ^{38}Cl was determined using β counting of radiochemically purified samples. A value of 37.18 ± 0.07 min was determined. (J.W.R.)

20358 CONFIGURATION MIXING IN THE CALCIUM ISOTOPES. Elton, L. R. B.; Webb, S. J. (Univ. of Surrey, Guildford, Eng.). Phys. Rev. Lett.; 24: 145-8(26 Jan 1970).

High-energy elastic electron scattering from ^{48}Ca and ^{48}Ca nuclei was fitted by means of a nuclear charge distribution obtained from single-particle wave functions with configuration mixing generated in a nonlocal, energy-independent potential well. (auth)

20359 NUCLEAR DATA SHEETS FOR A = 55. Auble, R. L.; Rapaport, J. (Oak Ridge National Lab., Tenn.). Nucl. Data, Sect. B.; 3: B3.3,4.1-195(Jan 1970).

Experimental data pertaining to the nuclear structure of ^{55}Cr, ^{55}Mn, ^{55}Fe, and ^{55}Co have been compiled, and the results of various measurements compared and evaluated. Adopted level properties, based on all available data, are obtained for each nucleus. An effort is made to construct as complete a set of level and decay properties as the data will allow. Inconsistencies found in the data are explicitly noted. The adopted level and decay properties are based on data received before May 1969. Data received between May and September 1969 have been "Added in Proof." (auth)

20360 DECAY SCHEME OF ^{46}K. Sugiyama, Kazusuke; Yagi, Masuo (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 60-6(Dec 1968). (In Japanese).

Decay scheme of ^{46}K was investigated and compared with the data given by Parsa and Gordon. ^{46}K was produced from ^{48}Ca by the reaction ^{48}Ca (γ,pn) with the bremsstrahlung of maximum energy 45 to 65 MeV, and chemically separated for measurement. Time for the irradiation was 1, 2 and 6 minutes. The γ-spectrum was measured using a 36 cc Ge(Li) semiconductor detector. The peaks in the spectrum which showed a decay of 2 minutes were attributed to ^{46}K. The relative intensity of the peaks was also obtained. The energy resolution of the detector was 4.0 keV at 1.3 MeV. Decay time of ^{46}K was obtained by measuring the decay of 1.345-MeV main peak and subtracting the long life component. The half-life thus obtained is 95 ± 5 sec. Decay scheme of ^{46}K based upon the present data was shown and compared with that given by Parsa and Gordon. Implications of the present result in nuclear shell model were discussed. (NSA of Japan)

20361 ANGULAR MOMENTUM OF THE EXCITED LEVEL OF 4081 keV IN ^{29}P. Gorodetzky, Serge; Beck, Francis; Byrski, Thadee; Engelstein, Pierre; Knipper, Albert (Centre National de la Recherche Scientifique, Strasbourg). Compt. Rend., Ser. B; 270: 231-3(19 Jan 1970). (In French).

The 4081-keV excited level of ^{29}P was obtained through the ^{28}Si(p,γ)^{29}P reaction, at the resonance E_p = 1382 keV. Angular correlations were measured for both cascades emitted by the excited level. Its angular momentum is J = 7/2. (France)

20362 THE DECAY AND HALF-LIFE OF ^{51}Mn. Erlandsson, B.; Marcinkowski, A.; Wall, N. (Lund Univ., Sweden). Ark. Fys.; 40: 139-44(1969).

The decay of a pure sample of ^{51}Mn, produced by proton bombardment of ^{50}Cr, was investigated. The half-life was measured as 2774 ± 7 sec. ^{51}Mn decays by positron emission and electron capture mainly to the ground state of ^{51}Cr. A weak branching to the first excited 748.5-keV level in ^{51}Cr was observed and the intensity of this relative to the intensity of the annihilation radiation from the positrons was determined. (auth) (Sweden)

20363 PROTON–INDUCED REACTIONS ON ^{40}Ar AND ANALOGS OF ^{41}Ar LEVELS. Scott III, Hugh Logan. Lexington, Ky.; Univ. of Kentucky (1967). 115p.

Thesis.

Differential cross sections were measured for the scattering of protons leaving ^{40}Ar in the ground and first excited states and also α-particles from the (p,α) reaction for protons of bombarding energy between 1.82 and 4.35 MeV with an energy resolution of <3.0 keV. In this energy region several resonances are observed in the energy-averaged cross sections which are analogs of bound levels in ^{41}Ar. The experimentally measured cross sections were averaged over a 20–26 keV energy range which was sufficient to remove most of the fine-structure fluctuations near the analog states. After averaging, the residual structure indicated the spreading of the analog strength into the fine-structure states. Fourteen of the resonances which were observed in the energy-averaged cross sections were analyzed using a sum of single level Breit–Wigner amplitudes which have been modified by the inclusion of an external mixing phase. The resonances treated in this analysis occur at incident proton energies of 1.88, 2.46, 3.39, 3.49, 3.56, 3.60, 3.71, 3.75, 3.89, 3.94, 3.96, 4.01, and 4.07 MeV. Resonance parameters were extracted for these levels and are compared to those obtained from analysis of the ^{40}Ar(d,p)^{41}Ar reaction. Although the resonances occur in elastic and inelastic scattering and in the (p,n) reactions, from this work no correlation was made between these channels and the competing (p,α) reaction. The analogs are completely missing in the (p,α) data. (Diss. Abstr.)

20364 STUDY OF NUCLEAR STRUCTURE BY RADIOISOTOPES. I. DECAY OF ^{86}Rb AND ^{142}Sm. Hayashibe, Syogo; Itagaki, Shinjiro (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 67-72(Dec 1968). (In Japanese).

Excited level of nucleus ^{86}Kr were investigated by measuring the gamma rays accompanying the β^+ decay of ^{86}Rb with half-life of 33.0 days. ^{86}Rb was produced by the reaction ^{85}Rb(γ,n). 50 mg of $RbNO_3$ was irradiated for three hours with bremsstrahlung of max. energy 60 MeV. Three days after the irradiation, the γ-ray spectrum of the sample was measured with Ge(Li) detector of effective volume 10cc. The relative intensity of transitions was measured and the ratio already reported as I $2nd_{\frac{5}{2}}^{+} \rightarrow 1st_{\frac{2}{2}}^{+}$/I $2nd_{\frac{5}{2}}^{+} \rightarrow$ ground$_{\frac{2}{2}}^{+} \approx$ 1/2 was ascertained. The excited levels of ^{142}Nd were also investigated by the same method. The decay ^{142}Sm → ^{142}Pm → ^{142}Nd was used. 100 mg Sm_2O_3 was irradiated for one hour with bremsstrahlung of 70 MeV max. energy. The γ-ray spectrum of sample was measured using 36 cc Ge(Li) detector. Because natural Sm was used in this measurement, contamination due to ^{152}Sm greatly limited the precise determination. (NSA of Japan)

20365 NOTE ON THE β DECAY OF ^{46}Sc. Ward, T. E.; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Radiochim. Acta; 12: 217(Dec. 1969).

A Ge(Li)–NaI(Tl) coincidence system was used to measure the β-γ coincidences for the decay of ^{46}Sc. The 0.524-MeV γ ray was found in coincidence with a β endpoint energy of 3.05 MeV. The 1.122-MeV γ-ray was found in coincidence with a 3.60-MeV β ray. The β decay Q-value and log-ft values were determined. The γ transitions were placed in the ^{46}Ti level scheme. (J.W.R.)

20366 LIFETIMES IN SOME EVEN NUCLEI IN THE s-d SHELL. Currie, W. M.; Earwaker, L. G.; Martin, J.; Sen Gupta, A. K. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., A (London); 3: 73-8(Jan 1970).

Mean lifetimes were measured by the Doppler shift attenuation method for several nuclei in the s-d shell. Both Ge(Li) and NaI(Tl) detectors were used. The results (in ps) for the energy levels indicated in parenthesis (MeV) were: ^{24}Mg (1.37) 2.07 ± 0.34, (4.23) 0.110 ± 0.026; ^{30}Si(2.23)0.332 ± 0.021, (3.51) 0.063 ± 0.015; ^{34}S (2.13) 0.467 ± 0.090, (3.30) 0.144 ± 0.028; ^{38}Ar (2.17) 0.473 (3.38) 25, ^{40}Ar (1.46) 2.45. (UK) (auth)

20367 STUDY OF LEVEL STRUCTURE OF ^{48}Ti BY THE DECAY OF ^{48}Sc AND ^{48}V. Sugiyama, Kazusuke; Nakata, Akira (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 73-80(Dec 1968). (In Japanese).

The level structure of ^{49}Ti was investigated using the decay of ^{49}Sc and ^{49}V. Natural vanadium (^{51}V 99.8%) was irradiated with bremsstrahlung of 45 to 60 MeV max. energy, and then was separated chemically into scandium and vanadium. After the decay of short life activity, γ-decays of ^{49}Sc, ^{48}Sc, ^{46}Sc and ^{49}V were measured with 36 cc. Ge(Li) detector (resolution 4 KeV at 1.33 MeV). By varying the max. energy of bremsstrahlung, yield of these nuclei can be varied, which allowed the γ-ray assignments. Results obtained are shown and compared with that given by the Amsterdam group. Various disagreements were found and discussion was given. The decay scheme of ^{48}Sc and ^{49}V was constructed based upon the present measurement. For the assignment of spin and parity, the intensity ratio of various transitions were calculated and compared with the experiment. Implications of the experiment on the nuclear shell model are discussed. (NSA of Japan)

20368 p,d AND p,t REACTIONS IN THE 2S–1D SHELL. Haight, Robert Cameron. Princeton, N. J.; Princeton Univ. (1969). 224p.

Thesis.

The p,d and p,t reactions on several 2s-1d shell nuclei were studied with 17.5-MeV protons. The p,d reaction on the following targets was investigated: ^{19}F, ^{23}Na, ^{25}Mg, ^{26}Mg, ^{27}Al, ^{29}Si, ^{30}Si, and ^{31}P. The p,t reaction was studied with targets of ^{19}F, ^{26}Mg, and ^{31}P. Differential cross sections for each reaction were measured at many angles. The angular distributions for single neutron transfer were compared with DWBA calculations to give spectroscopic information. Positive parity assignments are made for the 2.36-MeV state of ^{26}Al and for the 2.73- and 2.94-MeV states of ^{30}P. Negative parity assignments are confirmed for several states of ^{19}F and ^{23}Na and those with significant 1-p hole strengths are identified. The spectroscopic factors for single neutron pickup are compared with the predictions of shell model calculations, of the rotational model and of the unified model. The rotational (strong coupling) model accounts well for the spectroscopic factors extracted from the ^{25}Mg(p,d)^{24}Mg data. This model also accounts for many of the spectroscopic factors in the ^{23}Na(p,d)^{22}Na, ^{26}Mg(p,d)^{25}Mg, ^{27}Al(p,d)^{26}Al and ^{29}Si(p,d)^{28}Si reactions. On the other hand, the spectroscopic factors for s-wave neutron pickup in the ^{19}F(p,d)^{18}F reaction are not accounted for by the strong coupling model; a shell model calculation does account for them, however. The ^{30}Si(p,d)^{29}Si and ^{31}P(p,d)^{30}P cross sections have not yet been explained by any of these models. (Diss. Abstr. Int., B)

20369 THE REACTION ^{23}Na(p,p) IN THE RANGE 8.0 TO 12.0 MeV. II. EVIDENCE FOR AND INTERPRETATION OF INTERMEDIATE STRUCTURE. Hellstroem, J.; Dallimore, P. J.; Davidson, W. F. (Australian National Univ., Canberra). Nucl. Phys.; A140: 378-84(1970).

The selective occurrence of intermediate structure in the compound nucleus ^{24}Mg observed in the excitation functions for decay through different exit channels is interpreted on the basis of the statistical model of intermediate structure of Moldauer and the compound nucleus theory of Hauser and Feshbach. (auth)

20370 HIGH-RESOLUTION INVESTIGATION OF THE ^{30}Si(τ,d)^{31}P REACTION. Wolff, A. C.; Leighton, H. G. (Univ., Utrecht). Nucl. Phys.; A140: 319-32(1970).

The differential cross sections for the ^{30}Si(^{3}He,d)^{31}P and ^{30}Si(^{3}He,^{3}He$_0$)^{30}Si reactions at E = 12 MeV and of the ^{31}P(d,d$_0$)^{31}P reaction at E = 8 and 12 MeV were measured with a 90 cm split-pole magnetic spectrograph. The results of the ^{30}Si(^{3}He,d)^{31}P reaction are compared with DWBA calculations, from which l-values and spectroscopic factors are extracted. The l-values of the following levels are reported for the first time: 5.34 MeV l = 4, 5.89 MeV l = 4, 6.59 MeV l = 3, 6.84 MeV l = 3, 6.91 MeV l = 1 and 6.93 MeV l = 2. For the 6.46 MeV level in l-value of 2 is found, which is in disagreement with the result reported from the ^{30}Si(d,n)^{31}P reaction. A combination of the present results with additional information obtained from the previously investigated ^{30}Si(p,γ)^{31}P reaction, leads to the following J^π assignments of ^{31}P bound states: $J^\pi(4.59) = 3/2^+$, $J^\pi(5.56) = 3/2^+$, $J^\pi(5.99) = 3/2^-$, $J^\pi(6.59) = 1/2^-$, $J^\pi(6.61) = 3/2^-$, $J^\pi(6.84) = 1/2^-$, $J^\pi(6.91) = 3/2^-$ and $J^\pi(6.93) = 1/2^+$. (auth)

20371 A STUDY OF THE LOW-LYING STATES OF ^{23}Mg. Haun, L. C. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Roberson, N. R.; Tilley, D. R.; Nucl. Phys.; A140: 333-58(1970).

Nine excited states of ^{23}Mg were investigated by the ^{24}Mg(^{3}He, αγ)^{23}Mg reaction at ^{3}He bombarding energies of 6.37 and 8.05 MeV. Alpha-gamma angular correlations were measured using a collinear geometry. From these measurements and in conjunction with known l$_n$ values, spin and parity assignments of $1/2^+$, $1/2^{(+)}$ ($1/2$), $1/2^+$, $3/2^{(+)}$($1/2$), $1/2^-$($3/2^-$), $1/2^+$($1/2^+$), $3/2^-$, ($1/2^+$), and $1/2^+$ are established for the levels at 0.451, 2.048, 2.356, 2.712, 3.768, 2.904, 3.792, 3.968 and 4.353 MeV, respectively. Branching ratios were determined for these levels and also the γ-ray mixing ratios for most of the transitions. The decay modes of the 2.712 and 2.768 MeV levels were determined by a coincidence experiment utilizing a Ge(Li) detector. The results of this experiment are compared with other measurements, and weighted averages for the branching and mixing ratios are obtained. The predictions of the strong coupling collective model are compared with these averages. (auth)

20372 LIFETIME OF THE 1.37 MeV STATE IN ^{24}Mg. Herrmann, D.; Kalus, J. (Technische Hochschule, Munich). Nucl. Phys.; A140: 257-60(1970).

A source of ^{24}NaCl provided the resonant gamma radiation for the excitation of the 1.37 MeV level in ^{24}Mg. The mean lifetime of this level was determined in a self-absorption experiment as $\tau = 1.11 \pm 0.13$ ps. (auth)

20373 ELASTIC SCATTERING OF ^{3}He PARTICLES ON Ca AT FIVE INCIDENT ENERGIES BETWEEN 18.8 AND 39.3 MeV. Nakanishi, N.; Chiba, Y.; Awaya, Y.; Matsuda, K. (Inst. of Physical and Chemical Research, Yamato, Japan). Nucl. Phys.; A140: 417-43(1970).

Differential cross sections for the elastic scattering of ^{3}He particles by natural Ca at incident energies of 18.8, 24.9, 31.0, 34.4, and 39.3 MeV were measured and analyzed in terms of the optical model. Angular distributions have been measured in steps of 2.5° or 5° between 10° and 170°. The present analysis shows that the optical model gives a good description for the elastic scattering of ^{3}He particles on Ca in the measured energy range. However, there exist some ambiguities in optical-model parameters as in the case of other particles, that is, the parameter groups with the real potential depth of 90, 130, 180, 240 or 320 MeV, and those with the imaginary potential of a volume or surface absorption type, reproduce experimental angular distributions of differential cross sections. The form factor of surface absorption does not need an anomalously large radius for the imaginary potential of the ^{3}He scatterings. Furthermore, comparisons of reproducibility of angular distributions with and without the real part of the spin-orbit potential are made for each parameter group. A spin-orbit potential of about 4 MeV explains the backward behaviour of angular distributions. The analysis was carried out with an automatic parameter search program. (auth)

20374 EFFECTS OF FINITE RANGE AND EXCHANGE INTERACTION IN (p,n) AND (n,p) KNOCKOUT REACTIONS. Liu, K. H.; Ivash, E. V. (Univ. of Texas, Austin). Nucl. Phys.; A140: 444-64(1970).

Angular distributions based on the distorted-wave Born approximation taking into account the effects of finite range and exchange interaction have been calculated for four (p,n) and one (n,p) knockout reaction for target nuclei with atomic mass numbers between 13 and 91, for bombarding energies from 5.3 to 20 MeV, and for a wide range of bound state orbital angular momenta. Finite range is treated both exactly and approximately, using various approximations, and the results are compared with each other. An admixture of Wigner, Majorana, Bartlett and Heisenberg interactions with a Yukawa potential form factor is assumed for the neutron-proton interaction. The Woods–Saxon potential is used to evaluate the bound state wave functions. Experimental comparisons have been made for the ^{12}C(p,n)^{12}N and ^{28}Si(n,p)^{28}Al ground state reactions. Neither the zero-range approximation, nor any of the other approximations considered yield results which quantitatively are consistently reliable. Many of the cross sections exhibit a great sensitivity to exchange mixtures at certain angles, as well as to the bound state wave functions, and it may be possible in future investigations to take advantage of this property to determine nuclear parameters. (auth)

20375 STRUCTURE OF ^{21}Na FROM THE ^{24}Mg(p,α)^{21}Na REACTION. Pronko, J. G.; Lindgren, R. A.; Bromley, D. A. (Yale Univ., New Haven). Nucl. Phys.; A140: 465-80(1970).

The lower excited states of ^{21}Na were studied using the ^{24}Mg(p, α)^{21}Na reaction at a bombarding energy of E_p = 17.5 MeV. From analysis of particle-ray-γ angular correlations the spins of the 332, 1723 and 2834 keV states were found to be J = $1/2$ or ($3/2$), $1/2$ or ($3/2$) and $3/2$ or ($5/2$), respectively. Branching and multipole mixing ratios were obtained as well as evidence for a doublet of states with excitation energies 2833.8 ± 4.0 and 2803.5 ± 5.0 keV. This removes a puzzle of long standing concerning an apparent missing state in ^{21}Na as compared to the mirror nucleus ^{21}Ne. The experimental information obtained in the present study is compared with that for the mirror nucleus, ^{21}Ne, and discussed in terms of a Coriolis coupling model. These data, and those to be reported in subsequent papers for adjacent nuclei, suggest strongly that these nuclei may well be among the most rigid in nature. (auth)

20376 A STUDY OF THE $^{40}Ca(d,p)^{41}Ca$ REACTION. I. THE SINGLE-PARTICLE STATES. Seth, Kamal K. (Northwestern Univ., Evanston, Ill. CEN de Saclay, Gif-sur-Yvette, France); Picard, J.; Satchler, G. R. Nucl. Phys.; A140: 577-97(1970).

The reaction $^{40}Ca(d,p)^{41}Ca$ was studied with a resolution ≤30 keV. Excitation functions for the first three strong states have been measured in the energy interval 9.80 to 12.12 MeV. Cross section fluctuations are found to be entirely within statistics, i.e., <5%, and it is concluded that $\sigma_{CN}(\theta)/(2J_f + 1) < 5$ μb/sr. Differential cross sections have been measured for elastic scattering, and the (d,p) transitions to the ground state and the strong single-particle states at $E^* = 1.949$, 2.471, 3.623 and 3.954 MeV at $E_d = 12.00$ MeV and, over a limited angular range, at $E_d = 11.00$ MeV. The angular distributions have been analyzed by the DWBA method and spectroscopic factors have been determined. It is suggested that the 3.623 MeV state may be the third $\frac{3}{2}^-$ state predicted by Gerace and Green rather than $\frac{1}{2}^-$ as assigned by earlier studies. (auth)

20377 β−γ(CP) CORRELATION MEASUREMENTS AND ANTI-ANALOGUE STRUCTURE IN THE DECAY OF ^{49}Ca. Mann, L. G. (Univ. of California, Livermore); Bloom, S. D. Nucl. Phys.; A140: 598-608(1970).

β−γ(CP) correlation measurements have been carried out on the $\frac{3}{2}^-(\beta^-)\frac{3}{2}^-(\gamma)\frac{1}{2}^-$ sequence in the decay of the ground state of ^{49}Ca to the (presumed) anti-analog state at 3.105 MeV excitation in ^{49}Sc. An asymmetry parameter of $A = -0.132 \pm 0.017$ was obtained, making any spin-parity assignment other than $\frac{3}{2}^-$ very unlikely for the 3.105 MeV state. The deduced Fermi matrix element for the decay is $|M_V| = |1.4 \pm 9.7| \times 10^{-3}$, which leads to an isospin impurity ($T = \frac{5}{2}$ mixed into $T = \frac{1}{2}$) corresponding to the mixing of the analog state (at 11.6 MeV) and the 3.105 MeV state of $|\alpha|^2 \lesssim 1.6 \times 10^{-5}$. This leads in turn to an effective Coulomb matrix element of $|H_C = 3.9 \pm 27.4|$ keV, a low value compared to the value of ≳100 keV obtained from a theoretical estimate based on simple shell-model wave functions for the $2p_{\frac{1}{2}}$ and $1f_{\frac{5}{2}}$ single-particle states involved. (auth)

20378 EFFECTS OF SPHERICAL AND DEFORMED STATE MIXING ON THE E2 RATES BETWEEN THE ODD-PARITY STATES OF ^{40}Ca. Goode, Philip (Rutgers–The State Univ., New Brunswick, N. J.). Nucl. Phys.; A140: 481-93(1970).

Several E2 decay schemes for the low-lying T = 0 odd-parity states of ^{40}Ca are discussed. It is shown that a pure RPA description of these decays is not satisfactory. Gerace and Green have mixed these pure RPA states with 3p−3h deformed states to describe the T = 0 odd-parity states. In the calculation of the E2 rates with their wave functions, the intrinsic quadrupole moment of the band is taken to be a parameter so that several cases may be considered. It is thus shown that only one choice for the intrinsic quadrupole moment leads to a consistent explanation of the B(E2) values. Furthermore, the choice for the intrinsic quadrupole moment is the only one which is consistent with those of the even parity states in ^{40}Ca. (auth)

20379 STUDY OF THE STRUCTURE OF ^{36}S AND ^{38}Ar. Gray, W. S.; Ellis, P. J.; Wei, T.; Polichar, R. M.; Jaenecke, J. (Univ. of Michigan, Ann Arbor). Nucl. Phys.; A140: 494-522 (1970).

The $^{37}Cl(d,^3He)^{36}S$ and $^{39}K(d,^3He)^{38}Ar$ reactions have been studied at a bombarding energy of 28.9 MeV. The results are compared with theoretical calculations for two or four holes in the sd-shell. The three-hole spectrum of ^{37}Cl is also briefly discussed. In the calculation for ^{38}Ar, additional states of a two-particle four-hole nature are included. In ^{38}Ar, the ground state and levels at 2.166 and 7.14 MeV are excited principally by l = 2 transfer, while transitions with appreciable l = 0 strength are observed to levels at 3.935, 4.569, 5.158 and 5.563 MeV. This fragmentation is quite well reproduced by the inclusion of the 2p−4h states. In particular the level at 3.935 MeV is largely of this type, a conclusion supported by both the spectroscopic factors and γ transition rates. The ^{36}S ground state and levels at 6.511 and 7.12 MeV in ^{36}S have angular distributions characteristic of l = 2. Three transitions with l = 0 strength are observed to levels at 3.295, 4.523 and 4.577 MeV in this nucleus. An additional level was identified at 7.71 but the l-transfer could not be determined. The data are only qualitatively reproduced by the four-hole calculation, which while useful in making probable J^π assignments suggests that core excitation is important here also. (auth)

20380 STUDIES IN THE VIBRATIONAL SPLITTING OF THE GIANT DIPOLE RESONANCE. II. ^{58}Ni AND ^{60}Ni. Owen, D. G.; Muirhead, E. G.; Spicer, B. M. (Univ. of Melbourne, Parkville, Victoria). Nucl. Phys.; A140: 523-8(1970).

The total photoneutron cross sections for ^{58}Ni and ^{60}Ni have been measured with bremsstrahlung from threshold to 24 MeV. Although their magnitudes are greatly different, the two cross sections show similar structure over the giant dipole resonance region. The structural features of both are in only fair agreement with the dynamic collective model calculations of Huber, and of Seaborn, Drechsel, Arenhövel and Greiner. However the agreement of the ^{60}Ni cross section and the collective correlations calculation of Seaborn et. al. is far better, and thus indicates the importance of shell-model aspects. (auth)

20381 THE DECAY OF 91 min ^{78}As. McMillan, D. K.; Pate, B. D. (Simon Fraser Univ., Burnaby, British Columbia). Nucl. Phys.; A140: 529-47(1970).

The energies and relative intensities of γ rays following the β decay of ^{78}As (and ^{76}As) to levels in ^{78}Se (and ^{76}Se) have been measured using an 8 cm^3 Ge(Li) spectrometer. The β decay of ^{78}As has been measured using a superconducting magnet beta-ray spectrometer with two 3 mm thick Si(Li) detectors. These data plus β−γ and γ−γ coincidence results have been used to construct a level scheme with 18 excited levels in ^{78}Se. The half-life of ^{78}As was measured to be 90.7 ± 0.2 min. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 18901, 18948, 19214, 19577, 20085, 20122, 20272, 20292, 20325, 20329, 20352–20354, 20364, 20453, and 20621.

20382 (JAERI–1184) NUCLEAR PHYSICS IN ENERGY REGION OF TANDEM ACCELERATORS. Conference held at Tokai, Japan, December 19–21, 1968. Maruyama, Michio; Kikuchi, Shiroh (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Apr 1969. 150p. (In Japanese and English). (CONF-681221). Dep. CFSTI (U. S. Sales Only).

Separate abstracts were prepared for 28 of the 29 papers included. (J.W.R.)

For abstracts of individual papers see: 20267–20269, 20320, 20321, 20340–20347, 20383, 20384, and 20417–20429.

20383 (JAERI–1184, pp 88-91) THE STRUCTURES OF ^{141}Pr, ^{143}Pm, AND ^{117}In BY $(^3He,d)$ REACTIONS. Ishimatsu, Toshiyuki (Tohoku Univ., Sendai (Japan)). (In Japanese).

Experiments of the $(^3He,d)$ reactions on ^{140}Ce, ^{142}Nd and ^{116}Cd were made with a ^3He beam from a fixed-frequency cyclotron. Deuterons emitted from the targets were analyzed with a broad range magnetic spectrograph. Spectra of deuterons from the $(^3He,d)$ reactions on the neutron closed shell nuclei ^{140}Ce and ^{142}Nd are very simple showing six and five distinct peaks, respectively, up to an excitation energy of about 4 MeV. These spectra are in contrast with deuteron spectra for the $(^3He,d)$ and (d,p) reactions on the proton closed shell nuclei of tin isotopes, where far more peaks are seen in about the same range of excitation. Values of the orbital angular momentum transfer l and the spectroscopic factor S deduced from the DWBA analysis of the angular distributions of these deuteron groups are well consistent with the simple shell model picture. Deuteron spectra for the $^{116}Cd(^3He,d)^{117}In$ reaction are complicated. The ground $(\frac{9}{2}^+)$, first excited (0.314-MeV, $\frac{1}{2}^-$) and second excited (0.589-MeV, $\frac{5}{2}^-$) states are weakly excited in this reaction as expected from the shell model configuration of the target nucleus. There are, however, several states excited strongly below an excitation energy of about 2 MeV. In particular, l = 2 transitions to the 0.66- and 0.88-MeV states and an l = 0 transition the 0.75-MeV state are observed. Some authors suggested a possibility of the k = $\frac{1}{2}$ rotational band in ^{117}In based on the $\frac{1}{2}^+[431]$ state. Evaluated spectroscopic factors for proton stripping transitions to members of the proposed rotational band are in serious disagreement with the present experimental ones. Moreover, an l value of 2 for the transition to the 0.88-MeV state obtained in the present study is inconsistent with a spin-parity assignment of $\frac{1}{2}^+$ to this state assumed in the proposed rotational band. It remains open to question why the l = 0 and 2 proton stripping transitions to these low-lying states in ^{117}In are observed. (auth)

20384 (JAERI−1184, pp 92-5) EFFECTIVE PROTON-NEUTRON INTERACTIONS IN THE NUCLEI OF 90 ≤ A ≤ 140. Yagi, Kohsuke (Osaka Univ. (Japan)).

The Z dependence of neutron-single hole (particle) energies in ^{139}Ce, ^{117}Sn and ^{91}Zr is explained on the basis of effective p−n interactions. A tensor force with the radial dependence of r^2 type is effective. (auth)

20385 STUDY OF THE (d,3n) REACTION ON ^{197}Au. Chevarier, Alain; Chevarier, Noelle; Tran Minh Duc; Tousset, Jean

(Univ., Lyon). Compt. Rend., Ser. B; 270: 182-4(12 Jan 1970). (In French).

The excitation function of the $^{197}Au(d,3n)^{196}Hg$ reaction was drawn. The number of ^{196}Hg nuclei formed was determined by neutron activation. (auth) (France)

20386 I. THE $|\Delta K| = 1$ ELECTRIC DIPOLE TRANSITIONS IN ODD-MASS DEFORMED NUCLEI. II. THE DECAY OF ^{178}Ta TO LEVELS IN ^{178}Hf. Bernthal, Frederick Michael. Berkeley, Calif.; Univ. of California (1969). 340p.

Thesis.

In Part I elements of the collective and single-particle nuclear models are combined to provide a unified model interpretation of the $|\Delta K| = 1$ electric dipole transitions in odd-A deformed nuclei. Attention is focused on the uniquely informative set of E1 transitions in ^{177}Hf that results from decay of the singular ^{177m}Lu nucleus. It is shown that the influences of Coriolis coupling, pairing, and octupole vibration-particle coupling may be used to successfully account for the anomalous E1 transition rates in ^{177}Hf, and by implication, in other odd-A deformed nuclei. Precise experimental data were gathered for comparison with the theory. In Part II a detailed experimental study of the decay of ^{178}Ta to levels in ^{178}Hf is described. Numerous semiconductor detection systems were employed in conjunction with an on-line PDP-7 data acquisition system to gather γ-ray singles, conversion electron, and $\gamma-\gamma$ coincidence data on this remarkably complex decay. Over 300 transitions were observed to follow the ^{178}Ta decay, and some 140 of these were placed in the proposed ^{178}Hf level scheme. The experimental data on levels in ^{178}Hf is compared with contemporary theoretical expectations. Also attention is called to the exceptional quantity and quality of information on nuclear properties that can now be expected from the timely marriage of semiconductor-detector and on-line computer technology. The techniques and problems associated with precision γ-ray spectroscopic data acquisition and analysis are discussed. (Diss. Abstr.)

20387 NUCLEAR SPECTROSCOPY OF FISSION FRAGMENTS OF ^{252}Cf. Eddy, Nelson Wallace. Tempe, Ariz.; Arizona State Univ. (1969). 113p.

Thesis.

A study was made to determine the feasibility of sorting ^{252}Cf fission fragment gamma rays by atomic number Z using an x-ray-gamma-ray coincidence technique. No attempt was made to sort these gamma rays by half-life of the fission fragments, although it is expected that most of these gammas will be prompt ($\tau \sim 10^{-9}$ sec). As a criterion for success of the technique, separation of the gamma spectra of cesium and barium fission fragments was attempted. A 0.8 $cm^2 \times 3$ mm Si(Li) diode, cooled by liquid nitrogen, was used to detect the x rays and a 30 cm^3 Ge(Li) coaxial detector was used for the gamma rays. The former provided an energy resolution of 1.6 KeV FWHM on the 31.0 Kα x ray of cesium, the latter a resolution of 6.0 KeV FWHM on a 276 KeV ^{133}Ba gamma peak. By comparing intensities in the coincidence spectra, gamma rays of energy 130.0, 184.0, 204.8, 218.1, 237, 241.6, 249.9, 258.8, 270.3, and 276.5 keV were attributed to cesium and 138.9, 144.1, 171.3, 228.0, and 289 keV gammas were assigned Z = 56 (barium). Other spectral peaks were either unresolved by the Ge(Li) detector or had intensities too similar to make a firm identification. Still others were of low intensity and presumed to be background peaks. Agreement with the results of other researchers was made in every case of common attempts at providing Z assignments. It is on the basis of this agreement that the x-gamma coincidence method employed here is considered a valid and valuable experimental technique for determining the atomic number Z of gamma emitters. This technique would of course be useful in other experiments where it is desired to learn the Z-value of gamma emitters (e.g., irradiation of an impure target by accelerated neutrons or charged particles). (Diss. Abstr.)

20388 HOLE-VIBRATION COUPLING IN ^{205}Tl AND ^{203}Tl. Covello, A. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples). pp 1-8 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

A coupled hole-plus-vibration model was used to calculate the energy spectra, magnetic moments, strengths, and transition probabilities for ^{205}Tl and ^{203}Tl. The results are in good agreement with experimental data. (J.W.R.)

20389 THE YIELD OF ^{72}Zn IN THE EPI-Sm FISSION OF ^{239}Pu. Tong, S. L.; Fritze, K. (McMaster Univ., Hamilton, Ont.). Radiochim. Acta; 12: 179-82(Dec 1969).

The yield of ^{72}Zn in the epi-Sm fission of ^{239}Pu was measured and was found to be 30 ± 1% lower than in the fission of ^{239}Pu caused by reactor-spectrum neutrons. Similarly the yields for ^{115}Cd and ^{112}Pd were found to be lower by 46 ± 1% and 24 ± 3%, respectively. The yields of ^{97}Zr, ^{97}Nb, $^{99}Mo-^{99}Tc$, ^{132}Te, ^{132}I, ^{133}I, ^{138}Xe, ^{143}Ce did not show any significant fluctuations. The results are consistent with the two-mode fission hypothesis. (auth)

20390 CORE POLARIZATION EFFECT ON THE MAGNETIC MOMENT OF THE $(h_{\frac{9}{2}}^2)\,8^+$ STATE OF ^{210}Po. Yamazaki, T. (Tokyo Univ. Inst. of Physical and Chemical Research, Saitama, Japan); Nomura, T.; Katou, U.; Inamura, T.; Hashizume, A.; Tendou, Y. Phys. Rev. Lett.; 24: 317-19(16 Feb 1970).

The g factor of the $(h_{\frac{9}{2}}^2)\,8^+$ state of ^{210}Po was determined to be 0.911 ± 0.010 by the pulsed generation of the aligned isomeric state in the reaction $^{208}Pb(\alpha,2n)$. This g factor agrees within 1% with that of the $h_{\frac{9}{2}}$ ground state of ^{209}Bi, indicating that the $h_{\frac{9}{2}}$ proton carries the same renormalized anomalous magnetic moment both in ^{209}Bi and in ^{210}Po. (auth)

20391 TRANSITIONS OF ^{230}Th EXCITED IN THE ELECTRON-CAPTURE DECAY OF ^{230}Pa. Briand, Jean-Pierre; Chevallier, Pierre; Borg, Janet; Teillac, Jean (Institut de Physique Nucleaire, Paris). Compt. Rend., Ser. B; 269: 582-5(29 Sep 1969). (In French).

The γ spectra emitted in the decay of ^{230}Pa were studied with a gamma spectrometer with Ge(Li) detectors. A certain number of new gamma lines were observed. (tr-auth)

20392 NUCLEAR STRUCTURE OF ^{153}Sm, ^{155}Gd, ^{157}Gd, AND ^{159}Gd. Shida, Yoshijiro. Tallahassee; Florida State Univ. (1969). 148p.

Thesis.

The energy levels in ^{153}Sm, ^{155}Gd, ^{157}Gd, and ^{159}Gd were investigated by means of $^{154}Sm(d,t)^{153}Sm$, $^{154}Gd(d,p)^{155}Gd$, $^{156}Gd(d,t)^{155}Gd$, $^{156}Gd(d,p)^{157}Gd$, $^{158}Gd(d,t)^{157}Gd$, $^{158}Gd(d,p)^{159}Gd$ and $^{160}Gd(d,t)^{159}Gd$ reactions. The reactions were studied at 12-MeV deuteron energy with a magnetic spectrograph. Cross sections were analyzed in the DWBA theory of the stripping and pickup reactions and spectroscopic factors were extracted. The study of proton angular distributions has led to the determination of transferred orbital angular momenta. The results are used to identify states with the Nilsson orbitals; 14 different orbitals are observed in these nuclei and assignments of two β-bands in ^{155}Sm and ^{155}Gd are suggested. Comparison of the spectroscopic factors with the two theoretical predictions, one for the Nilsson potential and the other for the deformed Saxon-Woods potential, has shown the latter potential to be preferred over the former. Single particle energy ordering and band head energy systematics were in good agreement with the predictions of both potentials except for the orbitals originating from the 82 neutron shell. Effects of the hexadecapole deformation upon the single particle orbitals are examined for the Sm and Gd isotopes. Introduction of a positive Y_{40} deformation into the deformed potential has diminished differences between the experiment and the potential model predictions regarding the single particle level ordering, band head energy systematics, [521↓] decoupling parameters and the $\Delta N = 2$ mixing matrix elements. (Diss. Abstr.)

20393 THE DECAY OF 2.9-DAY ^{97}Ru. Cook, W. B.; Schellenberg, L.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 48: 217-24(15 Jan 1970).

NaI(Tl) and Ge(Li) detectors were used singly and in a two-parameter configuration to study the gamma rays associated with the decay of 2.9-day ^{97}Ru. Thirteen transitions were observed and accounted for in a decay scheme involving levels at 96.4, 215.8, 324.4, 656.7, 785.1, 855.4, 969.7, and 994.4 keV. Spin and parity assignments are discussed. (auth) (Canada)

20394 MUON- AND PION-INDUCED FISSION OF URANIUM ISOTOPES. Budick, B.; Cheng, S. C.; Macagno, E. R.; Rushton, A. M.; Wu, C. S. (Columbia Univ., New York). Phys. Rev. Lett.; 24: 604-7(16 Mar 1970).

The energy distributions of fission fragments following formation of muonic and pionic ^{233}U and ^{235}U were measured. Earlier results on the mean lives for muon capture by ^{235}U and ^{238}U are confirmed, and the study was extended to ^{233}U. Additional data have also been obtained on the process whereby a muon induces fission by transferring its excitation energy to the nucleus in a radiationless transition to the 1s level. (auth)

20395 MIXING OF TWO-PARTICLE, TWO-HOLE STATES IN ^{208}Pb. Igo, G. J.; Barnes, P. D.; Flynn, E. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 24: 470-3(2 Mar 1970).

The two-neutron transfer reactions $^{206}Pb(t,p)^{208}Pb$ and $^{210}Pb(p,t)^{208}Pb$ were employed to study states in ^{208}Pb. Several strongly excited states up to 6-MeV excitation can be described as two-

particle, two-hole states with strong correlations between the two particles and separately between the two holes. The cross sections to such two-particle, two-hole states are found to be in qualitative agreement with those observed for the 2^+ states in ^{206}Pb and ^{210}Pb in the (p,t) and (t,p) reactions, respectively. A state with $J^\pi = 0^+$ near 5.2-MeV excitation in ^{206}Pb is discussed in terms of a two-octupole phonon wave function. (auth)

20396 LEVEL STRUCTURE OF ^{120}Sn. Sugiyama, Kazusuke; Itagaki, Shinjiro (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 73-9(Jun 1969). (In Japanese).

New excited levels are proposed for ^{120}Sn. The decay of ^{120}Sb was studied with the help of a Ge(Li) detector (effective volume 36 cc). ^{120m,g}Sb were prepared by the (γ,n) reaction with 30-MeV bremsstrahlung. New gamma-rays of 0.704 and 0.990 MeV were observed. The levels at 1.876 (0^+) and 2.162 MeV (0^+) are proposed. (auth) (NSA of Japan)

20397 SOME EVIDENCE FOR ADMIXTURE OF MAGNETIC QUADRUPOLE RADIATION IN ATOMIC X-RAY TRANSITIONS FROM MEASUREMENTS OF ANGULAR CORRELATION OF X RAYS. Catz, A. L. (Univ. of Massachusetts, Boston. Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.: 24: 127-30(26 Jan 1970).

Angular correlations between K and L x rays in Pb were measured. The angular correlation functions for the $K-L_\alpha$ and $K-L_\beta$ cascades were found to be $W(\theta) = 1 + (4.13 \pm 0.36) \times 10^{-2} P_2 (\cos \theta)$ and $W(\theta) = 1 + (1.22 \pm 0.42) \times 10^{-2} P_2 (\cos \theta)$, respectively. These results are in relatively good agreement with theoretical predictions only when the small admixtures of magnetic quadrupole radiation in the x-ray transitions are taken into account. (auth)

20398 EVIDENCE FOR PARTICLE–QUASIHOLE STATES IN ^{124}Sn. Flynn, E. R.; Beery, J. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 24: 143-5(26 Jan 1970).

An analysis of differential cross-section data for the reaction ^{122}Sn(t,p)^{124}Sn indicates that strongly excited levels seen at an excitation energy of 5.5 MeV may be of the particle-quasihole type. Such levels are formed in the (t,p) reaction by transferring one neutron into one of the usual quasihole states of tin and the other neutron into one of the levels in the next major shell above tin. The position of such levels yields information on the energy gap between the two major shells as well as information on the quasiparticle configuration of ^{122}Sn. It is shown that the coherence which produces the strong (t,p) ground-state transition also would give added strength to these states. (auth)

20399 NUCLEAR REACTIONS WITH γ-RAYS. Syoda, Katsufusa; Sugawara, Masumi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No. 2, 37-40(Dec 1968). (In Japanese).

Energy distribution and angular distribution of the proton from the reaction (e,e'p) were measured with a broad range spectrometer. An electron beam from the electron linac was directly introduced to the target in the scattering cell of the spectrometer. This is equivalent to the (γ,p) reaction with the virtual photon accompanying the electron. Target nuclei were the neutron magic with N = 50, 82 and 126 (^{90}Zr, ^{140}Ce and ^{208}Pb). The energy distribution of emitted proton was shown. With ^{90}Zr and ^{140}Ce as targets, sharp resonance peaks due to analog state were found. For ^{88}Sr, ^{208}Pb and ^{209}Bi, the peak seemed to exist, but was not clear. For ^{89}Y, ^{139}La and ^{141}Pr, no resonance peak was found. The comparison with the cross section of corresponding (p,γ_0) reaction showed that some of the peaks could not be observed in (p,γ_0) reaction. The 90° symmetry of angular distribution of the proton from analog state was expected. The result of the measurements is shown. (NSA of Japan)

20400 STUDY OF ANALOGUE STATES USING (γ,p) REACTION. Syoda, Katsufusa; Sugawara, Masumi (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 30-46 (Jun 1969).

The isobaric analog states of ^{88}Sr, ^{89}Y, ^{90}Zr and ^{92}Mo which have closed shells of 50 neutrons were investigated by the (γ,p) reaction. The targets were bombarded by an electron beam, and the energy and angular distribution of protons were measured. Strong proton groups were found in the energy distribution for ^{90}Zr. Contributions of residual states around 0, 1.5, 3, 5, and 7 MeV for proton emission are shown. Comparisons with the inverse reaction (p,γ_0) were made. A systematic study of isobaric analog states in the (γ,p) reaction was made on Sn isotopes having different numbers of neutrons in the $1h_{11/2}$ shell (^{116}Sn, ^{118}Sn, ^{120}Sn and ^{124}Sn). Bombarding energy was about 20 MeV. Proton groups were found in the region of 7.6 ~ 8.5 MeV for every nuclei. Experiment with nuclei having closed shells of 82 neutrons also showed strong proton groups at 10.3 and 12.8 MeV for ^{140}Ce. For ^{141}Pr and ^{144}Sm, the proton groups were not so strong as for ^{140}Ce. (NSA of Japan)

20401 USE OF PLASTIC VISUAL DETECTORS FOR THE STUDY OF FISSION INDUCED BY HEAVY IONS. Debeauvais, Monique; Stein, Roland; Remy, Gerard; Tripier, Jean (CRN, Strasbourg). Compt. Rend., Ser. B; 269: 593-6(29 Sep 1969). (In French).

After a brief account of the technique and a description of the equipment used, several results are given concerning the fission cross sections of uranium, thorium, bismuth, and gold induced by neon-22, at 170 MeV at Dubna (USSR). The values found are of the order of 1.3 barns. Two cases of ternary fission were analyzed; the approximate fragment masses are given in the hypothesis of invariant charge distribution. (tr-auth)

20402 DECAY OF 32.2 min ^{138}Cs TO ^{138}Ba. Nagahara, Teruaki (Rikkyo Univ., Yokosuka, Japan); Miyaji, Nobuyoshi; Kurihara, Hideaki; Mizuno, Yukiko; Ishizuka, Yasuhiro. J. Phys. Soc. Jap.; 28: 283-91(Feb 1970).

The decay of ^{138}Cs to levels in ^{138}Ba was studied with Ge(Li) detectors and Ge(Li)-NaI(Tl) coincidence spectrometer. On the basis of the singles and coincidence measurements, 33 gamma-ray transitions were observed. Thirty-one transitions except for the 773- and 1555-keV gamma rays are placed in a level scheme of ^{138}Ba consisting of the levels at 1436.0, 1898.5, 2217.6, 2306.8, 2442.7, 2445.1, 2582.8, 2639.8, 2681.8, 2881, 3051, 3339.7, 3368.1, 3560.5, 3643, 3858, 3922, 4166.9 and 4241.8 keV. A new level at 3368.1 keV that has not been observed by the ^{138}Ba(p,p'), ^{137}Ba(d,p) and ^{137}Ba(n,γ) experiments is proposed in the present work. The existence of collective 3^- state at 2881 keV was also confirmed from the decay of ^{138}Cs. The results are compared with those of the previous studies. (auth)

20403 A NUCLEAR STRUCTURE STUDY OF ^{141}Pr AND ^{143}Pm USING THE (^{3}He,d) REACTION ON ^{140}Ce AND ^{142}Nd. Ishimatsu, Toshiyuki; Ohmura, Haruko; Awaya, Takashi; Nakagawa, Takemi; Orihara, Hikonojo; Yagi, Kohsuke (Tokyo Univ.). J. Phys. Soc. Jap.; 28: 291-5(Feb 1970).

Deuterons from the (^{3}He,d) reaction on N = 82 nuclei ^{140}Ce and ^{142}Nd were measured at an incident energy of 27.30 MeV with a broad-range magnetic spectrograph. Up to 3 MeV of excitation, levels of ^{141}Pr at energies 0.0, 0.15, 1.14, 1.32 and 1.64 MeV and those of ^{143}Pm at 0.0, 0.28, 0.96, 1.17, and 1.40 MeV were observed. The differential cross sections for the transitions were analyzed with distorted-wave calculations. Values of the orbital angular momentum of the transferred proton and the spectroscopic factors of the transitions were obtained. (auth)

20404 EXTENSIVE LEVEL STRUCTURE OF NUCLEI EXCITED WITH (p,d) AND (p,t) REACTIONS. Taketani, Hiroshi; Adachi, Minoru (Tokyo Inst. of Tech.). Genshikaku Kenkyu; 14: No. 2, 99-133(Nov 1969). (In Japanese).

Preliminary results on the (p,d) and the (p,t) reaction are given: in the former reaction are ^{48}Ca(p,d)^{47}Ca, ^{88}Sr(p,d)^{87}Sr, ^{92}Mo(p,d)^{91}Mo, ^{138}Ba(p,d)^{137}Ba and ^{142}Nd(p,d)^{141}Nd, while in the latter ^{88}Sr(p,t)^{86}Sr, ^{92}Mo(p,t)^{90}Mo, ^{138}Ba(p,t)^{136}Ba and ^{142}Nd(p,t)^{140}Nd. The incident-proton energies were about 52 MeV, and the measuring system was an FM analyzer. Where a peak in the (p,t) reactions appeared, the affirmation of components was made by insertion of Al absorbers of suitable thickness. The range of excitation energies studied was up to about 14 MeV for the (p,d)^{47}Ca, ^{87}Sr and ^{91}Mo, and up to about 5 MeV for the (p,d)^{137}Ba and ^{141}Nd and for the (p,t)^{86}Sr, ^{90}Mo, ^{136}Ba and ^{140}Nd. The energy resolution over-all was about 100 keV for (p,d), and 120 keV for (p,t). The angles of particle emission were from 5 to 55°, with measurements at 3 to 5° intervals. (NSA of Japan)

20405 DECAY OF ^{130}Cs. Hayashibe, Syogo; Itagaki, Shinjiro (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 1: No 1, 50-4(1968). (In Japanese).

It has been reported that ^{130}Cs decays to ^{130}Xe by the emission of β^+ and K electron capture, and to ^{130}Ba by the emission of β^-, and that in both cases ^{130}Cs decays to the ground state of its daughter nucleus. In this investigation, the gamma-rays emitted in the decay of ^{130}Cs (+½, 30 min) were measured with a Ge(Li) detector of effective 10cc volume or with a 3"φ × 3" NaI(Tl) detector. As the results, gamma-rays of 538 (100%), 561 (3.8%), 588 (15.2%), 606 (3%), 862 (8.5%), 1100 (2.1%), 1400 (1.9%), 1608 (6.4%), 1680 (2.0%) and 1706 keV (1.0%) were detected. By considering gamma-ray energy, its intensity, and single and sum spectra, the level scheme is proposed. In this experiment, it was revealed that ^{130}Cs decays also to the excited states of 538 (2^+), 1100 (2^+), 1126 (0^+), 1400 (2^+), 1706, 2150, and 2210 keV. (NSA of Japan)

20406 A STUDY OF NUCLEAR ENERGY LEVELS BY USE OF THE INS AIR CORE β SPECTROMETER. 2. A STUDY OF LEVELS

OF ^{135}La, ^{137}La AND ^{156}Tb. Hisatake, Kazuo; Fujioka, Manabu (Tokyo Inst. of Tech.). Genshikaku Kenkyu; 14: No. 2, 77-97(Nov. 1969). (In Japanese).

Internal conversion electrons following the decays of ^{135}Ce, ^{137m}Ce and ^{156m}Tb were measured with the INS air core β spectrometer (ρ = 75 cm). L sub-shell (or M sub-shell) conversions of the following transitions were resolved: the 34.5-, 59.0- and 88.8-keV transitions in ^{135}La, the 255-keV transition in ^{137}Ce, and the 10.54-keV transition in ^{137}La. The multipolarities and their mixing ratios were determined from the L (or M) sub-shell ratios. The 49.67-keV transition in Tb, which was recently discovered was found to belong to ^{156m}Tb. The fact that the intensity of the transition decays with the half-life of 23.4 hr and its multipolarity is E 1, which was determined by its L sub-shell ratio, suggests another isomeric state of 23.4 hr in ^{156}Tb. (auth) (NSA of Japan)

20407 PALLADIUM-97. Aten, A. H. W. Jr.; Kapteyn, Johanna C. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Radiochim. Acta; 12: 218(Dec 1969).

An activity with a half-life of 3.3 ± 0.3 min was found in the palladium fraction separated from ^{96}Ru activated with ^{3}He^{2+} ions. Relative intensities were measured for gamma lines of 265, 475, 792, and 938 keV. The activity was tentatively identified as ^{97}Pd. (J.W.R.)

20408 THE INTERPRETATION OF LONG-RANGE α PARTICLES FROM THE DE-EXCITATION OF ^{214}Po. Ythier, Christian; Maria, Henriette; Ardisson, Gerard (Laboratoire de Chimie Physique Atomique et Structurale, Nice). Compt. Rend., Ser. B; 269: 1003-6(12 Nov 1969). (In French).

A decay scheme is shown in which twelve of the fourteen groups of long-range alphas are interpreted as excited-state transitions of ^{214}Po toward the ground state of ^{210}Pb. The other two groups not indicated are doubtful. (J.F.P.)

20409 SPECTROSCOPY OF SOME BARIUM AND LANTHANUM NUCLEI. Abdul-Malek, Adel B. Princeton, N. J.; Princeton Univ. (1969). 171p.

Thesis.

Gamma-ray spectra of various isotopes were recorded using scintillation and semiconductor spectrometers. Conversion-electron spectra were recorded using a six-gap orange spectrometer, a semiconductor spectrometer, and a permanent-magnet spectrograph. Gamma-gamma and electron-gamma coincidence experiments were also performed. The systematic trends in the mass region 120 < A < 150 were surveyed. The applicability of several phenomenological nuclear models to this region is discussed. The energy-level structure of ^{135}La was investigated through the decay of ^{135}Ce. A revised level scheme incorporating a number of new levels was constructed. The spin and parity assignments of the various levels are discussed. The levels in ^{130}Ba, ^{132}Ba, and ^{134}Ba, populated in the decay chain supported by the corresponding cerium isotopes, were studied. Transitions that have been previously incorrectly assigned as following the decay of ^{133}Ce were reassigned as following the decay of ^{132}Ce. A tentative level scheme of ^{133}La was suggested. ^{134}La activity was extracted from mass-separated ^{134}Ce–^{134}La equilibrium mixture and the half-life of ^{134}La determined. The energy levels in ^{134}Ba populated in the decay of ^{134}Cs were studied. The existence of levels at 605, 1168, 1643, and 1970 keV was confirmed. No evidence for levels previously suggested at 923, 1062, 1374, 1567, 1770, or 1845 keV could be found. (Diss. Abstr. Int., B)

20410 SUBBARRIER FISSION OF ^{241}Am BY NEUTRONS. Shpak, D. L.; Ostapenko, Yu. B.; Smirenkin, G. N. JETP Lett. (USSR) (Engl. Transl.); 10: 175-8(20 Sep 1969).

Translated from Zh. Eksp. Teor. Fiz. Pis'ma Redaktsiyu; 10: 276-9(20 Sep 1969).

The cross section for the subthreshold fission of ^{241}Am was measured down to about E_k = 10 keV. The data indicate that the cross section behaves in approximately the same manner as for other threshold nuclei. (J.W.R.)

20411 ON THE CALCULATION OF CHARGE VALUES OF FISSION FRAGMENTS. Armbruster, P. (Kernforschungsanlage, Juelich, Ger.). Nucl. Phys.; A140: 385-99(1970).

The mass dependence of the average primary charge Z_p and the charge distribution in low-energy fission are calculated within the approximation of a quasi-static scission configuration. The deviation of Z_p from the unchanged charge density charge values Z_{UCD} is shown to be proportional to the first derivative in the charge coordinate of the potential energy whereas the width of the charge distribution is determined mainly by the second derivative. The experimental findings of a constant deviation ($Z_p - Z_{UCD}$), and constant width in the mass range of high yields in asymmetric fission is described satisfactorily within the model. An expression for a universal charge distribution in asymmetric fission is given. (auth)

20412 DESCRIPTION OF THE POSITIVE PARITY STATES IN ODD Xe ISOTOPES IN THE FRAMEWORK OF THE INTERMEDIATE COUPLING APPROACH OF THE UNIFIED MODEL. Paradellis, T.; Hontzeas, S. (Univ. of Saskatchewan, Regina). Nucl. Phys.; A140: 400-16(1970).

The nuclear structure and the properties of the lower lying levels in odd-mass Xe isotopes are investigated in the framework of the intermediate coupling approach of the unified model. It is assumed that the last odd neutron has available the $3s_{\frac{1}{2}}$ and $2d_{\frac{3}{2}}$ states and is coupled to the collective surface vibrations of the doubly even core of the nucleus. The Hamiltonian of the coupled system including all the states up to three phonons of quadrupole vibrations is diagonalized. In calculating the off-diagonal matrix elements, a reduction factor based on the occupation number of the state under consideration is used. The positive parity states in ^{127}Xe, ^{129}Xe, ^{131}Xe and ^{133}Xe are well reproduced by the model. The wave functions derived from the best fit were used to calculate nuclear moments and E.M. transition probabilities. The calculated magnetic moments compare favorably with the data. The calculated quadrupole moment for ^{129}Xe is in disagreement with the data, suggesting large collective interactions which the model does not account for. The model gives an over-all description of ^{131}Xe which is satisfactory with regard to the known half-lives and multipolarities of various transitions. Finally, the possible reasons for some of the discrepancies between the theoretical and experimental data are discussed. (auth)

20413 THE DECAY OF ^{158}Tb(150 y) TO LEVELS IN ^{158}Gd AND ^{158}Dy. Paperiello, C. J.; Funk, E. G.; Mihelich, J. W. (Univ. of Notre Dame, Ind.). Nucl. Phys.; A140: 261-74 (1970).

The decay of ^{158}Tb(150 y) to ^{158}Gd and ^{158}Dy has been studied with Ge(Li) detectors in singles and coincidence. The γ-ray transitions in Gd (total intensities in percent of total decays) are: 79.6 (80%), 181.9 (12%), 210.7 (0.01%), 780.2 (10%), 925.7 (0.05%), 962.2 (20%), 977.5 (0.16%), 1107.7 (2.1%) and 1187.2 keV (1.7%). It was established with coincidence techniques that there are two transitions of the same energy (to within 0.5 keV) at 898 keV with intensities of 0.11% and 0.17%. Transitions in ^{158}Dy are those of 99.0 (18%) and 218.2 (1.1%) keV. No evidence was obtained for a 720 keV transition in ^{158}Dy reported by others. The previously reported levels at 79.6 (2^+), 261.5 (4^+), 1023.7 (2^-), 1041.8 (3^-) and 1187.2 (2^+) keV in ^{158}Gd, and 99.0 (2^+) and 317.2 (4^+) keV in ^{158}Dy were confirmed. In addition, the 1^- level at 977.5 keV in ^{158}Gd is populated in the decay of ^{158}Tb, and a new state (possibly 4^-) is established at 1159 keV using coincidence techniques. A K = 1^- band (1^- through 5^-) based at 977.5 keV is postulated and the results of a band-mixing calculation with a K = 0^- band are in fair agreement with the energy spacings and branching ratios. An improved coincidence experiment measuring the ratio of K- to L-electron capture and L- to total-electron capture for decay to the 1187.2 keV (2^+) level shows that the energy available for electron capture to the state is less than 54 keV but greater than the L-shell binding energy. (auth)

20414 ISOBARIC ANALOGUE RESONANCES IN PROTON SCATTERING ON ^{138}Ba. Seitz, H.; Rieck, D.; von Brentano, P.; Wurm, J. P.; Zaidi, S. A. A. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A140: 673-87(1970).

Extensive experimental data for the resonance scattering of protons to the ground state and first excited state in ^{138}Ba are presented. A Breit–Wigner analysis with a background term of the form $\Sigma_n(a_n/E^n)$ is performed and the extracted background function is compared with optical-model calculations using the parameters given in a detailed investigation by Perey. Neutron spectroscopic factors calculated in different ways from this data are compared with the corresponding factors from (d,p). An accurate determination of resonance energies for the first two resonances reveals a deviation from a constant Coulomb shift of the order of 10 keV. (auth)

20415 DECAY OF ^{97}Ru, ^{97}Zr, AND ^{97}Nb. Hofstetter, K. J.; Sugihara, T. T. (Texas A and M Univ., College Station). Nucl. Phys.; A140: 658-72(1970).

The decay of ^{97}Ru, ^{97}Zr, and ^{97}Nb to levels in ^{97}Tc, ^{97}Nb, and ^{97}Mo has been studied with Ge(Li), NaI(Tl), plastic scintillation, and Si(Li) detectors in singles and coincidence experiments. Level schemes were constructed with states in ^{97}Tc at 96.5, 215.2, 324.4, (560), 785.5, 856 and 971 keV; in ^{97}Nb at 743.5, 1148.6, 1251.4, 1276.6, 1549.2, 1751.2, 1764.0, 1852.0, 2106.9 and 2247 keV; and in ^{97}Mo at 656.0, 1022.0, 1274.5 and 1514 keV. From β-endpoint energies, disintegration energies of ^{97}Zr and ^{97}Nb were determined to be 2580 ± 50 keV and 1830 ± 50 keV, respectively. Decay scheme considerations and an upper limit to the β^+/ec ratio established the disintegration energy of ^{97}Ru to be about 1100 keV. Neither the effective-interaction method nor the pairing-correlation model ac-

counts for the experimentally determined levels in mass-97 nuclei. (auth)

20416 GAMMA-RAY TRANSITIONS IN ^{197}Bi FOLLOWING THE DECAY OF ^{197}Po. Astner, G.; Alpsten, M. (CERN, Geneva). Nucl. Phys.; A140: 643-57(1970).

The decay of 5.7 h ^{197}Po to levels in ^{197}Bi has been studied using a Ge(Li) detector. Combining the relative gamma-ray intensities with previously established conversion electron intensities, K-conversion coefficients are determined. The multipolarities of 29 transitions are deduced from a comparison with theoretical conversion coefficients, thus establishing the following spins and parities for the excited levels: 669.5 keV ($1\frac{1}{2}^-$), 742.6 keV $\frac{1}{2}^-$, 892.3 keV ($\frac{3}{2}^-$), 992.3 keV $\frac{3}{2}^-$, 1148.3 keV $\frac{3}{2}^-$, (1360.4 keV $\frac{3}{2}^-$), 1372.4 keV $\frac{5}{2}^-$, 1680.0 keV $\frac{5}{2}^-$, (1690.6 keV $\frac{5}{2}^-$), 1762.7 keV $\frac{5}{2}^-$, 1902.0 keV $\frac{1}{2}^+$, 2060.0 keV $\frac{3}{2}^+$, and 2405.2 keV $\frac{5}{2}^+$. A comparison with a recent shell-model calculation shows good agreement for all negative parity levels. (auth)

Nuclear Theory

Refer also to abstracts 19260, 20053, 20089, 20140, 20187, 20188, and 20382.

20417 (JAERI-1184, pp 25-9) ANALYSIS OF THE HEAVY ION INDUCED TRANSFER REACTIONS. Kammuri, Tetsuo (Osaka Univ. (Japan)). (In Japanese).

Analysis of heavy-ion induced transfer reactions by use of the finite-range DWBA method is briefly described. (auth)

20418 (JAERI-1184, pp 30-5) STRUCTURE OF sd-SHELL NUCLEI. Arima, Akito (Tokyo Univ. (Japan)). (In Japanese).

The conventional shell model is applied to calculate properties of 1s0d shell nuclei. Although agreements with observations are generally satisfactory, a few characteristic discrepancies between the shell model calculations and observations are found. They are the positions of the K = 2 band, the positions of states with $\frac{1}{2}^+$, transition probabilities of excited 0^+ states. Some considerations are examined to remedy some of them. (auth)

20419 (JAERI-1184, pp 39-48) TOPICS IN OPTICAL MODEL OF NUCLEAR REACTIONS. Kawai, Mitsuji (Tokyo Inst. of Tech. (Japan)). (In Japanese).

Recent developments in the derivation of optical potential parameters for nucleon-nucleus scattering from the two-body nuclear forces are discussed. An argument in favor of the assumption of non-polarization of the target nucleus is given in terms of the coupled channel calculation of (p,p) and (p,p'). Possible sources of error in using the shell model t-matrix as the effective two-body interaction are pointed out. The optical model for deuterons is discussed. In particular, potentials used by Haeberli et al. and by Robson to account for j-dependence of (d,p) reaction which have a spin-orbit potential with a shorter radius than the central potential are discussed in some detail. (auth)

20420 (JAERI-1184, pp 52-6) NOTE ON THE OPTICAL POTENTIALS FOR COMPOSITE PARTICLES. Harada, Kichinosuke (Japan Atomic Energy Research Inst., Tokyo). (In Japanese).

In the theoretical estimation of the optical potential for a composite particle, the distortion and dissociation effects of the projectile cannot be disregarded. Wittern calculated the real part of the optical potential for alpha-nucleus scattering, taking those effects into account. In the first part of this note, his paper is reviewed briefly. In the second part, the real part of the optical potential for the three-nucleon system is calculated with his method. The depth of the real part is found to be about 100 MeV. (auth)

20421 (JAERI-1184, pp 67-71) TWO NUCLEON TRANSFER REACTION. Udagawa, Takeshi (Kyoto Univ. (Japan)). (In Japanese).

Nuclear structure information obtained from the two nucleon transfer reaction is discussed. In particular, the spectra of nuclei with the mass number A = 56 (and 56 ± 2) are analyzed based on the interaction matrix element of Kuo-Brown. It has been shown that the calculated T splitting between 0^+ states with the same intrinsic structure is smaller than the observed one and also the predicted excitation energies for particle and hole 0^+ pairing modes are too low as compared with experiments. The predicted energies for the quadrupole pairing modes are, however, fairly in agreement with experiments. It is also suggested that the 2.64-MeV first excited 2^+ state observed in ^{56}Ni is a one particle-hole state. (auth)

20422 (JAERI-1184, pp 72-8) PROPERTIES OF THE PRODUCT OF INITIAL AND FINAL DISTORTED-WAVES IN (t,p) REACTION. Kubo, Ken-ichi (Tokyo Univ. (Japan). Inst. for Nuclear Study). (In Japanese).

Concerning (t,p) reactions, not the features of each of the distorted waves, but those of the product of distorted waves in both channels were analyzed according to the selection rule about angular momentum. They are compared in compact form with form-factor and peak or valley features of angular distributions of protons. Such a product of distorted-waves may be useful to understand the characteristic properties of DWBA results. (auth)

20423 (JAERI-1184, pp 83-7) (^{3}He,p) REACTIONS ON LIGHT NUCLEI AND THE ISOSPIN PAIRING COLLECTIVE EXCITATIONS. Takahashi, Noriyuki; Iwasaki, Yoseo (Tokyo Univ. (Japan)). (In Japanese).

The neutron-proton correlations in light nuclei (A ≲ 40) are discussed from a viewpoint based on the recent theoretical works by Goswami and Kisslinger as well as by Danos and Gillet. A possible new mode of collective excitation (called here isospin pairing mode) which might be observed in the neutron-proton pair transfer reactions is suggested. This collective mode is due to the isoscalar part of the residual interactions in contrast to the pairing collective excitations which is brought about by the isovector part of the residual interactions (i.e., the pairing interactions between like nucleons). Relevant experimental results of (^{3}He,p) and (α,d) reactions are discussed in the light of the suggested viewpoint. (auth)

20424 (JAERI-1184, pp 96-9) ONE-NUCLEON-TRANSFER REACTIONS BY THE SUDDEN APPROXIMATION. Tanifuji, Makoto; Noya, Hiroshi (Hosei Univ., [Tokyo (Japan)]). (In Japanese).

Qualitative features are investigated for the (d,p) transition amplitude by the sudden approximation. It is pointed out that the amplitude consists of the momentum-distribution term studied in high energy (p,d) reactions and the term similar to that by Breit and Ebel for the ^{14}N(^{14}N,^{13}N)^{15}N reaction. The numerical result on the ^{40}Ca(d,p)^{41}Ca (g.s.) reaction is discussed in relation to these terms. (auth)

20425 (JAERI-1184, pp 101-12) ISOBARIC SPIN EFFECTS IN NUCLEAR REACTIONS. Taketani, Hiroshi (Tokyo Inst. of Tech. (Japan)). (In Japanese).

Experimental aspects on the isobaric analog states in various nuclear reactions and transitions are briefly reviewed. The possibility of using these analog states as a powerful tool to investigate the nuclear structure is discussed. The splitting of reaction strengths in single nucleon transfer reactions on singly or doubly closed shell nuclei with sizeable neutron excess is discussed in some detail. Possible isobaric spin effects involved are suggested. (auth)

20426 (JAERI-1184, pp 113-14) CONFIGURATION STATES IN (f,p) SHELLS. Oda, Takeshi (Tokyo Inst. of Tech. (Japan)). (In Japanese).

A comment on the determination of the effective n-p interaction, making use of the core polarization, is given. (auth)

20427 (JAERI-1184, pp 120-2) GAMMA DECAYS OF ISOBARIC ANALOGUE STATES AND BETA DECAYS. Fujita, Jun-Ichi (Tokyo Univ. (Japan). Inst. for Nuclear Study). (In Japanese).

Recently the measurement of gamma-rays from isobaric analog states has become an important tool to obtain information concerning the corresponding beta decays. Several remarks are made from theoretical viewpoints. (auth)

20428 (JAERI-1184, pp 131-40) NUCLEAR RELAXATION AND ITS ANALOGY IN THE PROPERTIES OF BULK MATERIAL. Yanabu, Takuji (Kyoto Univ. (Japan)). (In Japanese).

The nuclear reaction mechanism is reviewed from the standpoint of its time sequence. The similarity between the nuclear relaxation and mechanical relaxation of visco-elastic materials is noted. The response characteristics of the nucleus to the pulse action of the incident particle are discussed referring to the recent development in the field of computer experiments on the equilibrium attainment of many particle systems. (auth)

20429 (JAERI-1184, pp 146-9) INVERSE PHOTONUCLEAR REACTION. Tanaka, Eiji (Tohoku Univ., Sendai (Japan)). (In Japanese).

A brief review and several comments are made on the inverse photonuclear reaction. (auth)

20430 CARGESE LECTURES IN PHYSICS. VOLUME 3. Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969). 683p.

Separate abstracts were prepared for the 15 lectures included. (J.W.R.)

For abstracts of individual lectures see: 20388 and 20431–20444.

20431 GENERATOR COORDINATE THEORY OF COLLECTIVE MOTION. Brink, D. M.; Weiguny, A. (Oxford Univ.). pp 9-19 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The formulation of the generator coordinate theory of collective motion in nuclei is reviewed. The method successfully combines the phenomenological and microscopic approaches. Some numerical results are briefly discussed. (J.W.R.)

20432 COEXISTENCE OF SHELL MODEL AND DEFORMED STATES IN LIGHT NUCLEI. Federman, P. (Franklin Inst., Swarthmore, Pa.). pp 21-87 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The problem of reconciling the shell model and deformed states in light nuclei is examined in detail. Various approaches for describing nuclear structure in the region of oxygen and calcium isotopes are reviewed. It is concluded that the inclusion of core excited states leads to the understanding of the main features in the spectra of light nuclei near closed shells. (75 references) (J.W.R.)

20433 ISOBARIC SPIN MIXING IN GROUND STATES OF NUCLEI. Warke, Chindhu S. (Tata Inst. of Fundamental Research, Bombay. Niels Bohr Inst., Copenhagen). pp 89-95 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The isospin impurity effects of the Coulomb interaction in nuclear ground states are estimated in a rigorous manner using single determinant wave functions. The results are compared with other calculations. (J.W.R.)

20434 ISOVECTOR MAGNETIC MOMENTS OF MIRROR NUCLEI. Leonardi, R. (Univ., Bologna). pp 97-103 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The construction of the magnetic dipole operator of nuclear isodoublets is discussed. The role played by the structure of the dipole operator and of the nuclear wave function in giving matrix elements in accord with the experimental results is analyzed. (J.W.R.)

20435 NUCLEAR STRUCTURE, FISSION, AND SUPERHEAVY ELEMENTS. Nilsson, Sven Goesta (Univ. of California, Berkeley). pp 105-81 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The fission and alpha-decay properties of the actinides and superheavy elements are examined. The general problem of nuclear stability as seen from the viewpoint of the semiempirical mass formula is briefly outlined. Modifications brought about by the deformation-dependent shell model are considered. Spontaneous fission is discussed both from the dynamic and static viewpoints. Possible methods for production of superheavy elements are also discussed. (J.W.R.)

20436 A STUDY OF THE SYMMETRY OF TWO-BODY INTERACTIONS IN RELATION WITH THEIR PAIRING CORRELATIONS PROPERTIES. Arvieu, Robert (Institut de Physique Nucleaire, Orsay, France). pp 183-250 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The generalized seniority scheme is studied extensively. The pairing force and the surface delta interaction are seen to be diagonal in that scheme. This scheme is compared to the one in which the sum of the individual seniority of the subshells is diagonal; the former interaction is still diagonal in that scheme, while the latter, as well as any reasonable interaction, is not. A tensor expansion of the two body interaction is carried out, as proposed by R. D. Lawson and M. H. MacFarlane, in which three terms are extracted. One is diagonal in the scheme considered, its magnitude is examined in the case of several two body interactions. It is seen to be preponderant most of the time. On the other hand for the interactions composed of this single term the number of quasi-particles introduced by Bogolyubov and Valatin is seen to be identical with the generalized seniority quantum number. A second term, which has the character of a vector under quasi spin rotations, is always present in the hamiltonian. In the case of the pairing force it does not modify essentially the structure of the wave functions of the system; indeed, an extended seniority scheme can be defined. The last term, a tensor of rank two, can introduce large mixing. This term is also estimated for many forces. The quadrupole force is the interaction for which this term is by far the largest. It leads to correlations which are outside the scope of the B.C.S. method. The method suggests then that the success of the B.C.S. method is related to the presence in the interaction of a small tensor term. (auth)

20437 GROUP THEORY AND THE FEW-NUCLEON PROBLEM. Moshinsky, M. (Univ. de Mexico, Mexico City). pp 251-329 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

Complete sets of three- and four-body translationally invariant states of definite angular momentum corresponding to specific irreducible representations of the symmetric group of three or four particles are constructed. Harmonic oscillator wave functions are used for the single-particle states in each relative coordinate. The four-particle states are used in discussing the form factor of the ^{4}He ground state and the energies of some of the excited states. (J.W.R.)

20438 GROUP THEORY AND THE NUCLEAR CLUSTER MODEL. Kramer, P. (Univ., Tuebingen, Ger.). pp 331-6 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The relation of the nuclear cluster model to the supermultiplet scheme, the physical significance of clustering, and the methods of group theory needed for handling cluster configurations are discussed. (J.W.R.)

20439 NUCLEAR FORCES AND THE STRUCTURE OF NUCLEI. Elliott, J. P. (Univ. of Sussex, Brighton, Eng.). pp 337-93 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The problem of deducing the nucleon–nucleon potential from two-body scattering data and applying it in nuclear structure calculations is reviewed. Topics covered in detail include potential matrix elements from phase shifts, the few-nucleon problem, first order calculations, second order calculations, and the G-matrix interpretation. (J.W.R.)

20440 NUCLEAR FORCES AND HARTREE–FOCK CALCULATIONS. Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. pp 395-449 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The use of soft-core potentials for the nuclear force in Hartree–Fock calculations is reviewed. Some numerical results are surveyed. (J.W.R.)

20441 SEMI-CLASSICAL THEORY OF SCATTERING. Brink, D. M. (Oxford Univ.). pp 451-81 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

A semi-classical approximation to a scattering process is constructed using the wave-packet formulation of collision theory. The method is well suited to nucleus-heavy ion scattering. (J.W.R.)

20442 NUCLEAR STRUCTURE EFFECTS IN NUCLEAR REACTIONS. Lemmer, R. H. (UNISA, Pretoria). pp 483-533 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The intertwined and complementary nature of nuclear reaction and structure studies in low-energy nuclear physics is discussed. Topics included are: a model problem, resonances, the actual nuclear scattering problem, analog states, and analog states as resonances. (J.W.R.)

20443 EIGENCHANNEL THEORY OF NUCLEAR REACTIONS AND ELECTRON SCATTERING. Greiner, Walter (Univ., Frankfurt am Main). pp 535-77 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The formulation of the eigenchannel theory and its applications to nuclear reactions and electron scattering are discussed. Some numerical results for the $^{16}O(\gamma,\rho)$ reaction are analyzed. The convergence of the eigenchannel method is demonstrated by comparing with an exactly soluble model. (J.W.R.)

20444 SELECTED TOPICS ON VIBRATIONAL NUCLEI. Alaga, G. (Univ. of Zagreb. Inst. Ruder Boskovic, Zagreb). pp 579-678 of Cargese Lectures in Physics. Vol. 3. /Jean, M. (ed.). New York; Gordon and Breach, Science Publishers, Inc. (1969).

The quadrupole and octupole vibrations and hole or particle coupling to these vibrational modes in the regions of spherical nuclei are reviewed. A large amount of experimental and theoretical data is surveyed. (49 references) (J.W.R.

20445 NUCLEON–NUCLEON POTENTIAL FOR ISOTOPIC TRIPLET STATE. Ulehla, I. (Charles Univ., Prague); Bystricky, J.; Wiesner, J.; Humhal, E.; Lehar, F.; Lelek, V. Czech. J. Phys.; 19: 1570-7(1969).

The nucleon–nucleon potential for the isospin triplet state is computed as a superposition of Yukawa-type potentials. It contains the central, spin, spin-orbit, quadratic spin-orbit and tensor term and is dependent on the total angular momentum J. The parameters of the individual terms are fitted to the experimental data. (auth)

20446 PREDICTIONS FOR FISSION FRAGMENT ANGULAR DISTRIBUTIONS FROM LOW-TEMPERATURE ALIGNED NUCLEI. Moretto, L. G.; Stella, R. (Univ., Pavia, Italy). Energ. Nucl. (Milan); 17: 118-24(Feb 1970).

Fission fragment angular distributions were considered for low-temperature aligned nuclei. Numerical calculations were performed for the cases of spontaneous fission, for neutron induced fission and for photofission. It was found that in all the cases the angular distributions are expected to be very well characterized so that the future experimental data should provide detailed information on the fission saddle point properties. (auth)

20447 ON THE PROBABILITY OF THE NUCLEAR DOUBLE β-DECAY IN REGION REMOVED FROM THE β STABILITY BAND. Berlovich, E. E.; Novikov, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR; 188: 1023-5(Oct 1969). (In Russian).

Studies of double β-decays showed that the periods of double β decays at regions removed from the β stability band were diminished significantly in comparison to the β-stable nuclei, for instance for two-neutrino variation the magnitude was of only several orders of years (for $A \simeq 60$ and neutron-saturated nuclei). The ratio of $\lambda_{2\beta}\sigma/\lambda_{2\beta}\nu$ increased with the increased decay energies (i.e. with the increased distance from the β-stability band). In contrast to the β-stability band in remote regions, the probabilities of two-neutrino and neutrino-free processes do not differ much and consideration of small deflection from the two-component neutrino condition or in the case of neutrino mass differing from zero, the probability of neutrino-free process was inhibited in comparison to the two-neutrino process. (R.V.J.)

20448 DEUTERON AMPLITUDES FROM A COMPOSITE-PARTICLE NUCLEAR SCATTERING THEORY. Smith, Temple Ferris. Boulder, Colo.; Univ. of Colorado (1969). 107p.

Thesis.

The problem of obtaining the scattering amplitudes of deuterons from nuclei is studied through a series expansion, in two-body transition amplitudes, of the three-body problem by means of the Faddeev equations. The interaction between the nucleons of the deuteron and the nucleus is assumed to be described by the optical model potential obtained phenomenologically from elastic scattering data. Thus from the more elementary nucleon scattering, the deuteron scattering amplitudes are obtained. As in all multi-body calculations, the two-body transition amplitudes are needed as a function of the propagator energy both on and off the energy shell. In an effort to obtain these amplitudes, a general method of calculating the two-body amplitudes was obtained which involved solving an inhomogeneous differential equation, rather than the usual Lippmann–Schwinger integral equation. The expansion of the Faddeev composite particle amplitudes into the two-body transition amplitudes was carried out to first and second order to obtain the deuteron elastic scattering amplitudes. The comparison with 22-MeV elastic scattering data on ^{58}Ni was quite good. However, an attempt to relate these calculated amplitudes to a local deuteron optical model potential raised some question as to the proper interpretation of such deuteron potentials. Finally the possible extensions of this approach to other composite particles was discussed. (Diss. Abstr.)

20449 THE EFFECT OF NUCLEAR SHELL-MODEL CONTINUUM STATES ON FORM FACTORS FOR PARTICLE TRANSFER REACTIONS. Ibarra, Rufino Herrera. Minneapolis; Univ. of Minnesota (1969). 87p.

Thesis.

A theory is developed for the proper treatment of the continuum–continuum interaction in the shell-model hamiltonian which uses a finite-range single-particle potential. The continuum contributions are treated by an extension of the diagonalization methods in the ordinary shell-model analysis. The method is then applied to the calculation of form factors for one particle and two-particle transfer reactions on ^{42}Ca and compared with the methods of other workers. Correlations introduced by mixing continuum states with the discrete configurations ensure the correct normalization and asymptotic dependence in the form factor. It is found that the continuum contributions have a little effect on the calculated energies but have a large effect on their radial wave functions and therefore a significant effect on the results of particle transfer reactions. (Diss. Abstr.)

20450 DIRECT INTERACTIONS WITH COUPLED CHANNELS. PART I. Hategan, C. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 20: 977-1004(1968). (In Rumanian).

The method of coupled channels, also called the generalized optical model or the strong-coupling approximation, is reviewed in detail. The direct interaction processes include: the direct inelastic scattering, the direct exchange reaction and formation of the compound nucleus through "doorway" states. The quantum-mechanical and mathematical formalisms of the strong coupling approximation are described, together with the usual notations and definitions. The coupled channels method is correlated with structural nuclear models and interaction mechanisms, examining also the quasiscattering and double-stripping reactions. A generalization of the Runge–Kutta numerical method is presented for a second-order, inhomogeneous differential equation. (TTT)

20451 POLARIZATION PHENOMENA IN NUCLEAR REACTIONS. POLARIZATION KINETICS. Borsaru, M.; Hategan, C. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 20: 1005-31(1968). (In Rumanian).

The kinetics of nuclear reactions involve relations resulting from the symmetry properties of space, time and the interactions. One of the fundamental values of nuclear reactions is the polarization of the reaction products; it yields valuable information about the reaction dynamics. The kinematics and dynamics of nuclear polarization reactions are examined, starting with the polarization of a beam. Determination of the polarization of protons in elastic scattering is used to illustrate the experimental technique. The absolute level of polarization is measured by M. J. Scott's method; it is based on the ability of a polarized beam to conserve its degree of polarization when it is slowed down. The phenomenon is given a quantum-mechanical treatment, involving the density matrix and statistical tensor concepts. (TTT)

20452 EFFECTIVE INTERACTIONS IN NUCLEAR STRUCTURE. de Llano, Manuel (Univ. of Mexico, Mexico City). Amer. J. Phys.; 38: 151-61(Feb 1970).

The basic notions associated with the idea of an "effective interaction" in nuclear physics are sketched by first recalling isolated two-body scattering analyzed with integral equations and in which the transition operator appears naturally. Brueckner's reaction matrix operator is discussed in the context of both infinite nuclear matter and finite nuclei with doubly closed shells. Finally, open-shell nuclei are touched upon by way of a many-body effective interaction operator deduced in simple language and a possible connection between this and the reaction matrix operator is given. It is emphasized throughout that the basic merit of the vantage-point sketched here is its fundamental origin in the many-body Schrödinger equation. (auth)

20453 HARTREE–FOCK CALCULATIONS WITH AN EFFECTIVE FORCE. Petry, H.-R.; Schuette, D.; Bleuler, K. (Univ., Bonn). Energ. Nucl. (Milan); 17: 53-61(Jan 1970).

Hartree–Fock calculations were carried out with a regularized realistic force which is in fair agreement with nucleon–nucleon scattering data in the relevant energy interval. A sequence of nuclei with closed subshells (^{16}O, ^{40}Ca, ^{72}Ge, ^{132}Sn, ^{208}Pb) was treated, whereby a second order correction was taken into account. Satisfactory values were obtained for binding, density and single-particle spectra (in particular the deep lying s-states) and a striking agreement with other methods was reached. (auth)

20454 ON THE ACCURACY OF THE JWKB METHOD IN ALPHA-DECAY. Ixaru, L. Gr. (Inst. for Atomic Physics, Bucharest); Kreuzer, H. J. Energ. Nucl. (Milan); 17: 62-4 (Jan 1970).

It is shown that the JWKB approach is a fairly accurate method for deriving penetrabilities for phenomenological potentials in α-decay. (auth)

20455 EXPERIMENTS ON (γ,α) REACTION. Abe, Ken; Kawamura, Nobuaki (Tohoku Univ., Sendai). Res. Rep. Lab. Nucl. Sci., Tohoku Univ.; 2: No. 1, 47-51(Jun 1969). (In Japanese).

Implications of the α-cluster model in nuclear shell theory are

discussed. Various difficulties of the α-cluster model by Perring-Skyrme, Sekine et al., Horie et al., and Arima et al., are reviewed. Ikeda proposed the Ikeda diagram showing the molecule-like structure of light nuclei. It was concluded that the α-decay of excited nucleus, its energy distribution and angular correlation will provide good information concerning the α-cluster structure in excited states. Because the electron linac at the Tohoku Univ. is very suitable for this experiment, measurement of the (γ,α) reaction was attempted. The rapid particle discrimination necessary for the measurement was realized and reported elsewhere. In the present experiment, counting rate was much lower than expected. The cause of the failure was examined. (NSA of Japan)

20456 FORMULATION OF BORN AMPLITUDES OF n-d SCATTERING WITH PHENOMENOLOGICAL NUCLEAR FORCES. Hasegawa, Kenji (Fukui Univ., Japan). Fukui Daigaku Kogakubu Kenkyu Hokoku; 17: 189-200(Sep 1969).

The Born amplitudes of elastic n-d scattering are formulated for the phenomenological nuclear forces of such a type as is proposed by Tamagaki. In terms of the scattering amplitudes, the basic formulas are also given for the various scattering parameters such as $I(\theta)$, $P(\theta)$, $D(\theta)$, $R(\theta)$, C_m and C_{KP}. (auth) (NSA of Japan)

20457 ISOSPIN POLARIZATION IN THE NUCLEAR MANY-BODY PROBLEM. Engelbrecht, C. A. (Atomic Energy Board, Pelindaba, S. Afr.); Lemmer, R. H. Phys. Rev. Lett.; 24: 607-11(16 Mar 1970).

For nuclei with N > Z, isospin invariance is explicitly broken in the Hartree-Fock (HF) approximation. It is shown that isospin polarization correlations in the HF ground state restore this symmetry and lead to a natural framework for a microscopic description of analog states. The approximations under which the Lane potential model is obtained are discussed. (auth)

20458 ASYMPTOTICALLY CORRECT SHELL MODEL FOR NUCLEAR FISSION. Scharnweber, D.; Mosel, U.; Greiner, W. (Univ., Frankfurt am Main). Phys. Rev. Lett.; 24: 601-3(16 Mar 1970).

A two-center shell model with oscillator potentials, $\vec{l}\cdot\vec{s}$ forces, and l^2 terms is developed. The shell structures of the original spherical nucleus and those of the final fragments are reproduced. For small separation of the two centers the level structure resembles the Nilsson scheme. This two-center shell model might be of importance in problems of nuclear fission. (auth)

20459 SINGLE-PARTICLE POTENTIAL FOR DEFORMED NUCLEI. Sobiczewski, Adam (Inst. for Nuclear Studies, Warsaw). Postepy Fiz.; 20: 649-59(1969). (In Polish).

The Nilsson single-particle potential for deformed nuclei, both in its original (1955) and in the latest (1966) versions, is discussed. (auth)

20460 KWIC INDEX OF NUCLEAR PROGRAMMES. Ispra, Italy; ENEA Computer Programme Library (1969). 87p.

A brief description in KWIC index form is given of the computer programs in the European Nuclear Energy Agency (ENEA) computer program library. (J.W.R.)

20461 NORMALIZATION FACTORS FOR STRIPPING REACTIONS. Thompson, W. J. (Univ. of North Carolina, Chapel Hill); Hering, W. R. Phys. Rev. Lett.; 24: 272-3(9 Feb 1970).

All of the normalization factors used in the zero-range distorted-wave Born-approximation analysis of single-nucleon stripping reactions with projectiles of $A \leq 4$ can be calculated by use of Hulthén potentials with a common short-range parameter $\beta = 1.36$ fm^{-1} and long-range parameters α obtained from the nucleon-separation energy from the projectile. The values obtained are in close agreement with previous determinations. (auth)

20462 STRIPPING TO UNBOUND STATES. Bunakov, V. E. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Phys.; A140: 241-56(1970).

An expression is given for the cross section of stripping to unbound states which allows the use of the slightly modified DWBA code of the ordinary bound-state stripping. The expression obtained is shown to have a resonant Breit-Wigner form when the unbound state is quasi-stationary. Application to the case of stripping to isobaric analog resonances is considered. (auth)

20463 SHAPE ISOMERIC STATES IN HEAVY NUCLEI. Tsang, Chin Fu; Nilsson, Sven Goesta (Univ. of California, Berkeley). Nucl. Phys.; A140: 275-88(1970).

The trend for the occurrence of secondary minima (shape isomers) in the potential-energy surface is discussed for an extended region of heavy nuclei. The calculations reported are based on a modified oscillator potential, and a renormalization of the average behavior of the total energy to that of the liquid-drop model is performed. The regions treated are the actinide region, the rare-earth region along the stability line, and a region of neutron-deficient isotopes of elements in the Pb region. (auth)

20464 FURTHER THEORETICAL RESULTS ON THE STABILITY OF SUPERHEAVY NUCLEI. Tsang, Chin Fu; Nilsson, Sven Goesta (Univ. of California, Berkeley). Nucl. Phys.; A140: 289-304(1970).

Theoretical results are exhibited for the stability of superheavy nuclei with $106 \leq Z \leq 128$ and $176 \leq N \leq 204$ with respect to various decay mechanisms. A discussion is given of the production of superheavy nuclei by heavy-ion reactions. In particular, the experimental possibilities associated with the ^{86}Kr beam are considered on the basis of the present calculations. (auth)

20465 SPIN-ORBIT COUPLING AND PROPERTIES OF THE NUCLEAR SURFACE. Stocker, W. (Univ., Munich). Nucl. Phys.; A140: 305-18(1970).

The influence of one-body spin-orbit forces (linear in spin and momentum) on nuclear surface properties is investigated. The single-particle model for semi-infinite nuclear matter bounded by an infinite barrier is assumed. The variations of the nuclear density and of the nuclear surface tension caused by the inclusion of spin-orbit terms are extracted. It is shown that a polarization of the surface arises as particles of one spin orientation are accumulated at the outer part of the surface. The surface energy coefficient increases by an amount of several MeV if a spin-orbit term of reasonable strength, as given by optical potential fits, is added. The spin-orbit potential may produce single-particle states which are localized at the nuclear surface. The importance of such states is pointed out. (auth)

20466 CALCULATIONS ON THE NUCLEAR SURFACE. Lin, Y. C. (Univ. of Arizona, Tucson). Nucl. Phys.; A140: 359-77(1970).

The surface properties of semi-infinite nuclei are calculated on the basis of the Thomson-Fermi theory by Bethe. Density-dependent effective nuclear forces are used, an integral equation is derived and solved on a computer. The surface of the mass density is found to be 2.5 fm, but folding in the finite size of the proton gives a thickness of 3.3 fm for the charge density, compared to a measured value of 2.4 fm. Various suggestions are made for reducing the calculated thickness. The electron scattering from the theoretical charge density is calculated and compared with experiment. The theoretical surface energy coefficient is 22-23 MeV for a semi-infinite nucleus, but is reduced to about 15 MeV by a simple-minded correction for curvature, compared to the semi-empirical value 18 MeV. (auth)

20467 THE USE OF GENERALIZED SUM RULES IN MANY-BODY THEORY. I. MICROSCOPIC DESCRIPTION OF NUCLEAR ROTATION. Gross, D. H. E.; Yamamura, M. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Nucl. Phys.; A140: 625-42 (1970).

Following a recent paper of Marumori et al., the idea of using sum rules expressing different single-particle transition operators in terms of higher powers of other operators is extended to the general case. With the help of these generalized sum rules a new microscopic method is developed to calculate energies and transition probabilities for nuclei within the rotational region. For simplicity the discussion is restricted to the single j-shell case with a quadrupole two-body interaction. The mass region where rotational phenomena may be expected is determined and is interpreted by a simple Hartree model. The calculated quadrupole moments and transition probabilities show excellent agreement with the exact calculations of Mulhail and Šips. (auth)

20468 LAMBDA-NUCLEON INTERACTION POTENTIALS. James, J. R.; Ram, B. (New Mexico State Univ., Las Cruces). Nucl. Phys.; A140: 688-96(1970).

Two-body S-wave, spin dependent, central Λ-N interaction potentials of the form first given by Ram and Downs are constructed to fit the zero energy scattering lengths $a_s = -2.25$ fm, $a_t = -2.08$ fm of Herndon and Tang. When assumed to be effective in even-parity states with full strength and in odd-parity states with zero strength, these potentials fit the Λ-p scattering cross section data very well. The binding energy D of the Λ-particle in nuclear matter using these potentials is calculated by the method of independent pair approximation. The potentials that best fit the scattering data give values for D which are only 3-4 MeV lower than that obtained previously with a potential of Herndon and Tang. It is concluded that the three-body ΛNN forces may be quite important in the calculations of D. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 19486.

20469 (CEA-CONF-1483) PRACTICAL RESULTS OBTAINED AFTER ELEVEN YEARS OF OPERATION FOR PRESTRESSED CONCRETE PRESSURE VESSELS. Dupay, F. (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). 1969. 24p. (In French). (CONF-691112-4). Dep. CFSTI (U. S. Sales Only).

From 2nd Conference on Prestressed Concrete Reactor Vessels and their Thermal Insulation, Brussels, Belgium.

Engineering statistics are presented. Study and construction of G2 and G3 pressure vessels have been rapidly conducted. Assumptions were made and risks taken, counterbalanced by safety design. No study of soil stability had been made. Geodesic control of foundation raft shows that marl tamping is less important than expected and its evolution in time is getting less and less significant. The reactor should work with a small temperature variation. After a detailed study of pressure vessel behavior with temperature, conditions allowing a 70°C variation are specified. Safety is based on the presence of prestresses. Cable protection against corrosion is secured by dry air circulation. Permanent stresses variations of prestressed cables are checked by dynamometric chocks. Pressure vessel also contains measuring instruments. (France)

20470 (DOCKET-50029-46) YANKEE NUCLEAR POWER STATION. License NO. DPR-3: Technical Specifications, Change No. 76. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 20, 1966. 11p. Dep. CFSTI.

Use of previously irradiated stainless steel clad fuel assemblies in Core VI of the Yankee Power Reactor is discussed. Thermal and neutronics characteristics of Core VI are analyzed. Safety aspects are considered. (M.L.S.)

20471 (DOCKET-50029-51) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 78. (Yankee Atomic Electric Co., Boston, Mass.). Dec. 30, 1966. 5p. Dep. CFSTI.

Permission to change boron concentration in the Yankee Power Reactor coolant is requested. Reduction of the boron concentration of an isolated main coolant loop and reasons for this reduction are discussed; safety aspects are considered. (M.L.S.)

20472 (DOCKET-50029-54) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 79. (Yankee Atomic Electric Co., Boston, Mass.). May 2, 1968. 4p. Dep. CFSTI.

An increase in pH of the Yankee Power Reactor is authorized; the lower pH limit is changed from 5.0 to 4.5 while the upper limit remains at 10.5. Effects of this change on the primary system and components are evaluated. Safety implications in the change are discussed. (M.L.S.)

20473 (DOCKET-50213-33) [CONNECTICUT YANKEE ATOMIC POWER PLANT]. Request for Temporary Waiver of the Variable Low Pressure Trip. (Connecticut Yankee Atomic Power Co., Westboro, Mass.). 13 Mar 1970. 3p. Dep. CFSTI.

Permission to remove the temperature trip signal in coolant Loop No. 1 of the Connecticut Yankee Power Reactor is requested; supporting information is given with respect to reasons for needing to remove the trip signal and plant operating conditions under which the trip will be removed. The procedure for recalibration of the temperature instrumentation in coolant Loop No. 4 is detailed. (M.L.S.)

20474 (DOCKET-50219-63) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Control Rod Drives. (Jersey Central Power and Light Co., Morristown, N. J.). 6 Mar 1970. 2p. Dep. CFSTI.

The functioning of the control rod drives for the Oyster Creek Power Reactor, Unit 1, is discussed briefly. Effects of use of wire mesh filters are considered. (M.L.S.)

20475 (HPR-119) FABRICATION AND OPERATION HISTORY OF THE HBWR PRESSURE VESSEL. Aas, Steinar (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Jan 1970. 60p. Dep. CFSTI (U. S. Sales Only). OECD Free.

The pressure vessel for the Halden Boiling Reactor is described. Topics discussed include: vessel design; materials; stress calculations; fabrication; pre-operational testing; operational history; and radiation induced embrittlement of vessel materials. 25 references. (D.C.C.)

20476 (ORNL-tr-2289) SHIELDING MEASUREMENTS IN THE RHEINSEERG NUCLEAR POWER PLANT. Dedicated to the 20th Anniversary of the DDR. Gerullis, W.; Michaelis, U. E.; Mertins, J. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Kernenergie; 12: 328-40(1969). 27p. Dep. CFSTI.

In the control rooms of the Rheinsberg Power Reactor the mean dose rate equivalent amounts to less than 6% of the permissible value of 1.25 mrem/h. The maximal values with homogeneous shielding are about $\frac{1}{10}$ to $\frac{1}{5}$ of the value of 1.25 mrem/h, and the dose rate found at irregularities is 0.1 to 6 mr/h. The present safety factors can be reduced by improved and further developed design principles, more exact calculations of the source strengths, refined calculation methods for determining the thicknesses of shielding, as well as choice of the best types of concrete and concrete technology. Further reductions in cost are possible if local peakings are permitted at irregularities. Unfortunately, up to the present, even internationally, there have been no uniform concepts concerning the permissible peaking of the dose rate. 18 references. (auth)

20477 (UJV-2046-R) OPTIMIZATION OF THE MAIN PARAMETERS OF FUEL ASSEMBLY FOR A2 REACTOR. Markvart, J.; Kujal, B.; Pernica, R.; Majeticova, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 33p. (In Czech). Dep. CFSTI (U. S. Sales Only).

The method and the results of the complex optimization calculations of the heavy water gas cooled reactor fuel assembly are presented. The fuel assemblies are in the form of a bundle of thin rods with longitudinal fins. Independent variable parameters considered include: the number of rods of the given diameter in a bundle; the fin height (with the constant number of 15 fins); and the coolant flow rate through the central assembly (the pressure drop along the bundle). For the optimization criterion the minimum of energy production costs in the reactor of a given size is taken. A graphical-analytical calculation method was used to evaluate inaccuracies in determining the physical characteristics of the active core. 6 references. (auth)

20478 NUCLEAR POWER PLANT AT LOVIISA. Numminen, K. (Imatran Voima Oy, Helsinki). Sahko; 43: No. 2, 33-6(1970). (In Finnish).

The Loviisa Power Reactor being built as a joint Soviet–Finnish venture will be a PWR. The reactor and turbines will follow the usual Soviet design, but the safety equipment and automation will comply with Finnish specifications. Special attention is being paid to easy maintenance. The processes are being divided into several parallel parts so as to reduce breakdowns caused by defective components to the minimum. (auth) (Finland)

20479 MEASUREMENTS OF PROTOTYPE PLUTONIUM ELEMENTS FOR THE GARIGLIANO REACTOR. Ariemma, A.; Bramati, L.; Cammarota, U.; (and others). Ing. Nucl.; 10: No. 4, 23-37(Jul-Aug 1969). (In Italian).

During the last shutdown of the Garigliano reactor for refueling (August–September 1968), a series of critical experiments were performed on assemblies containing reload enriched-uranium elements and prototype plutonium elements. The outcome of these experiments was information on the rod power density distributions associated with highly heterogeneous lattices and reactivity variations following replacement of enriched-uranium elements with plutonium elements. The technique used for power density measurements (gamma activity scanning by means of a NaI crystal) proved its outstanding capabilities, because it revealed minor effects on the power densities, such as those due to rod manufacturing tolerances. The good agreement observed in previous criticality experiments between the experimental values and those obtained with the calculation methods adopted by ENEL in the design of plutonium prototype fuel elements was fully confirmed. The power density was calculated with a standard deviation less than 2%, and reacticity with an error below 0.5%. 9 references. (auth)

20480 SWEDISH POWER INDUSTRY ENTERING THE NUCLEAR AGE. Ryman, J. R. Ing.; 81: E9-22(14 Feb 1969).

The present electric power resources in Sweden are discussed. Future demands for power and effects on power reactor development are described. (UKAEA Info. Bull.)

20481 RULES FOR INSERVICE INSPECTION OF NUCLEAR REACTOR COOLANT SYSTEMS. 1970 EDITION. ASME Boiler and Pressure Vessel Code, Section XI. New York; American Society of Mechanical Engineers (1970). 42p. $6.00.

20482 COMPARISON OF TYPES OF NUCLEAR POWER STATIONS IN RUMANIA. Wlezek, C. Bul. ISPE (Rumania); 11: 115-39(Mar 1968). (In French).

The rapid increase in power required by the developing industry of Rumania has led to a consideration of the building of a nuclear power station. The technical and economical features of suitable types of reactor are considered. The development of the technological processes inherent to a nuclear power station is considered both from a technical and an economic point of view. (UKAEA Info. Bull.)

Operation and Economics

20483 (DOCKET-1155-5) LA CROSSE BOILING WATER REACTOR. Monthly Operational Report No. 19, January 1969. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 11 Mar 1969. Contract AT(11-1)-850. 31p. (ACNP-69501). Dep. CFSTI.

20484 (DOCKET-1155-6) LA CROSSE BOILING WATER REACTOR. Monthly Operational Report No. 20, February 1969. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). 17 Apr 1969. Contract AT(11-1)-850. 22p. (ACNP-69502). Dep. CFSTI.

20485 (DOCKET-50016-33) ENRICO FERMI ATOMIC POWER PLANT, [UNIT 1]. [Operations] Report, November 1969. (Power Reactor Development Co., Detroit, Mich.). 10 Mar 1970. 12p. (PRDC-EF-75). Dep. CFSTI.

20486 (DOCKET-50029-50) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 77. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 20, 1966. 5p. Dep. CFSTI.

Operation of the Yankee Power Reactor with the reduction of the number of core thermocouples from 27 to 14 is discussed. The safety aspects and scheduling of the proposed change are considered. (M.L.S.)

20487 (DOCKET-50029-66) YANKEE NUCLEAR POWER STATION. Operation Report No. 85, January 1968. (Yankee Atomic Electric Co., Boston, Mass.). Feb. 26, 1968. 9p. Dep. CFSTI.

20488 (DOCKET-50029-67) YANKEE NUCLEAR POWER STATION. Operation Report No. 86, February 1968. (Yankee Atomic Electric Co., Boston, Mass.). Mar. 29, 1968. 8p. Dep. CFSTI.

20489 (DOCKET-50029-68) YANKEE NUCLEAR POWER STATION. Operation Report No. 87, March 1968. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 24, 1968. 9p. Dep. CFSTI.

20490 (DOCKET-50029-69) YANKEE NUCLEAR POWER STATION. Operation Report No. 88, April 1968. (Yankee Atomic Electric Co., Boston, Mass.). May 25, 1968. 14p. Dep. CFSTI.

20491 (DOCKET-50155-5) BIG ROCK POINT NUCLEAR PLANT. Eighth Semiannual Report of Operations, November 1, 1967-April 30, 1968. (Consumers Power Co., Jackson, Mich.). 24 Jun 1968. 26p. Dep. CFSTI.

20492 (DOCKET-50155-8) BIG ROCK POINT NUCLEAR PLANT. Ninth Semiannual Report of Operations, May 1-October 31, 1968. (Consumers Power Co., Jackson, Mich.). 27 Dec 1968. 14p. Dep. CFSTI.

20493 (DOCKET-50155-26) BIG ROCK POINT NUCLEAR PLANT. Quarterly Operations Report No. 76, November-January 1970. (Consumers Power Co., Jackson, Mich.). 1 Mar 1970. 17p. Dep. CFSTI.

20494 (DOCKET-50155-41) BIG ROCK POINT NUCLEAR PLANT. Monthly Operations Report No. 70, July 1968. (Consumers Power Co., Jackson, Mich.). 15 Aug 1968. 18p. Dep. CFSTI.

20495 (DOCKET-50171-26) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 47, January 1970. (Philadelphia Electric Co., Pa.). 16 Mar 1970. 19p. Dep. CFSTI.

20496 (NP-18103) THE ENERGY TRADE OUTLOOK IN THE COMMUNITY. Situation 1968; Perspectives 1969. (European Communities, [Luxembourg]. Commission). 136p. (In French). Dep. CFSTI (U. S. Sales Only). Central Sales Office for Publications of the European Communities, Luxembourg FF 10,-.

The economic and institutional framework of energy trade in the community is analyzed. The present energy needs are given, and covering of these needs by coal, petroleum, natural gas, and electricity is outlined. Predictions of the energy needs for 1969 are given. (J.S.R.)

20497 MATHEMATICAL MODEL FOR STUDYING A PROSPECTIVE OPTIMUM PATTERN OF NUCLEAR POWER PLANTS. Bercovici, M.; Szmuk, Al. Stud. Cercet. Energ. Electroteh.; 8: 531-45(1968). (In Rumanian).

Analytic relations have been developed for use on a digital computer to calculate the structural alternatives of a system of nuclear power stations consisting of one converting and one reproducing power station and select the optimum one. Methods are given for calculating the installed power in converting and reproducing power plants, the commissioning of these plants in terms of plutonium output, and of processed plutonium availabilities for different periods of time. The analytic formulation of some economic cost functions allowing for the selection of the alternative for which the basic economic functions display minimum values is also given. The model helps trace an optimized program for the development of nuclear stations also considering the over-all problem of the optimal structure of the primary energy resources in Romania. (Rom. Sci. Abstr.)

20498 A CONSIDERATION OF POWER SUPPLIES FOR THE PILBARA REGION, WESTERN AUSTRALIA. Baxter, Sir P.; Griffiths, D. R. (Australian Atomic Energy Commission). J. Inst. Eng., Aust.; 41: 107-12(Jul-Aug 1969).

Unless some low-cost fuel is discovered in this region, or some form of subsidy is provided, power will not be cheap, especially during the early developmental stages of the Pilbara region. Several sources of power, including nuclear energy, are considered. For the power demand envisaged, nuclear power would not be an economical proposition. An oil (or gas) fired steam plant would involve the minimum capital outlay and provide the lowest-cost energy. Designed for an output of about 180 MW it would provide power to industry at between 10 and 20 mills per unit. (Australia)

20499 COMPARISON OF NUCLEAR POWER PLANTS IN RUMANIA FROM ECONOMICAL AND NONECONOMICAL VIEWPOINTS. Wlezek, C. Bul. ISPE (Roumania); 11: No. 4, 111-35 (1968). (In French).

A comparison of the existing power reactor types according to 6 different economic criteria is presented. Comparison is made among several alternatives (one 600 MW(e) M.P.P., several nuclear power plants, etc.) and results are tabulated. An analysis of comparison criteria used is also made. (UKAEA Info. Bull.)

20500 ACCEPTANCE TESTS IN GUNDREMMINGEN 237 MW NUCLEAR POWER STATION. Herbst, R. Energie; No. 21, 82-9(Mar 1969). (In German).

The problems of acceptance tests, and measuring methods (especially of steam moisture and remote measurements of volumes, pressures and temperatures) are described. The rated load test gave a net output of 244.35 MW (design 237) and the net heat rate was 2,758 kcal/kWh (design 2,910). (UKAEA Info. Bull.)

20501 EUROPEAN REACTORS. FIVE CASE HISTORIES. Nucl. News; 13: No. 2, 31-50(Feb 1970).

Design parameters and operating experiences are reviewed for the Steam-Generating Heavy-Water-Moderated Reactor, the Swedish Reactor R-3, the Obrigheim Power Reactor, the Garigliano Power Reactor, and the Beznau Power Reactor Unit 1. (D.C.C.)

Safety and Siting

20502 (DOCKET-50003-26) INDIAN POINT STATION, UNITS 1, 2, AND 3. Survey of Environmental Radioactivity, February 1-July 31, 1966. (Consolidated Edison Co. of New York, Inc., New York). 20 Aug 1966. 24p. (DOCKET-50247-25; DOCKET-50286-20). Dep. CFSTI.

20503 (DOCKET-50003-27) [INDIAN POINT STATION, UNITS 1, 2, AND 3]. Ecological Survey of the Hudson River. Progress Report No. 2, February 1, 1965-January 31, 1966. (New York Univ., N. Y. Inst. of Environmental Medicine). 20 Dec 1966. 194p. (DOCKET-50247-26; DOCKET-50286-21). Dep. CFSTI.

For Consolidated Edison Co. of New York, Inc., N. Y.

20504 (DOCKET-50003-28) INDIAN POINT STATION, UNITS 1, 2, AND 3. Survey of Environmental Radioactivity, February 1–July 31, 1967. (Consolidated Edison Co. of New York, Inc., New York). 18 Aug 1967. 14p. (DOCKET-50247-27; DOCKET-50286-22). Dep. CFSTI.

20505 (DOCKET-50003-29) [INDIAN POINT STATION, UNITS 1, 2, AND 3]. Hudson River at Indian Point. Annual Report, April 1968–April 1969. (Consolidated Edison Co. of New York, Inc., New York). 5 Mar 1970. 198p. (DOCKET-50247-28; DOCKET-50286-23). Dep. CFSTI.

20506 (DOCKET-50003-30) [INDIAN POINT STATION, UNITS 1, 2, AND 3]. Hudson River at Indian Point. Quarterly Report, April 16–July 17, 1969. (Consolidated Edison Co. of New York, Inc., New York). 5 Mar 1970. 20p. (DOCKET-50247-29; DOCKET-50286-24). Dep. CFSTI.

20507 (DOCKET-50003-31) [INDIAN POINT STATION, UNITS 1, 2, AND 3]. Effect of Indian Point Cooling Water Discharge on Hudson River Temperature Distribution. (Quirk, Lawler and Matusky Engineers, New York). Jan 1968; Revised Feb 1969. 113p. (DOCKET-50247-30; DOCKET-50286-25). Dep. CFSTI.

For Consolidated Edison Co. of New York, Inc., N. Y.

20508 (DOCKET-50003-32) [INDIAN POINT STATION, UNITS 1, 2, AND 3]. Cooling Water Studies Model No. 2. (Worcester Polytechnic Inst., Mass. Alden Research Labs.). May 1969. 148p. (DOCKET-50247-31; DOCKET-50286-26). Dep. CFSTI.

For Consolidated Edison Co. of New York, Inc., N. Y.

20509 (DOCKET-50029-44) YANKEE NUCLEAR POWER STATION. License No. DPR-3: Technical Specifications, Change No. 75. (Yankee Atomic Electric Co., Boston, Mass.). Oct. 20, 1966. 28p. Dep. CFSTI.

Specifications of the frequency and acceptance limits for the Yankee Power Reactor containment system testing are defined. Minimum tests, acceptance criteria, corrective actions, and test frequency are described. (M.L.S.)

20510 (DOCKET-50029-84) [YANKEE NUCLEAR POWER STATION]. License No. DPR-3. [Plant Maintenance Instructions]. (Yankee Atomic Electric Co., Boston, Mass.). 6 Nov 1961. 24p. Dep. CFSTI.

20511 (DOCKET-50133-28) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications Proposed Change No. 29. (Pacific Gas and Electric Co., San Francisco, Calif.). 13 Mar 1970. 13p. Dep. CFSTI.

Design parameters for Jersey Nuclear Type 3 fuel assemblies for testing in the Humboldt reactor are presented. Comparisons with General Electric Type 3 fuel assemblies are included. Nuclear characteristics of a mixed core of Type 2 and Type 3 fuel assemblies are listed. (D.C.C.)

20512 (DOCKET-50146-49) SAXTON REACTOR. License No. DPR-4: Technical Specifications Change Request No. 38. (Saxton Nuclear Experimental Corp., Pa.). 20 Mar 1970. 6p. Dep. CFSTI.

A failed fuel element monitor for installation in Core 3 is described. The coolant monitor consists of GM tubes with a range of 1 mr/hr to 30 R/hr. System parameters and calibration procedures are listed. (D.C.C.)

20513 (DOCKET-50171-6) PEACH BOTTOM ATOMIC POWER STATION, [UNIT 1]. Final Hazards Summary Report, Part C, Vol. 5 (Appendices A–E). (Philadelphia Electric Co., Pa.). 3 Mar 1964. 273p. Dep. CFSTI.

The research and development program proposed for the Peach Bottom Power Reactor, Unit I, is described. The programs are outlined for: graphite integrity studies, nuclear design, fission product control, flow model program, fuel element testing, control rods and drives, emergency shutdown rod and drive, thermally released adsorbers, tests on shaft seals for main helium loop compressors, and fuel transfer machine test. Projected radioactivity inventories are tabulated for all components and systems. Results of complete loss of coolant are analyzed; core heatup and thermodynamic calculations are detailed. Steam generator tube ruptures are discussed; results of this type of accident are analyzed. Normal and emergency operating procedures are detailed. (M.L.S.)

20514 (DOCKET-50220-35) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. [Violation of Technical Specifications]. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 6 Mar 1970. 2p. Dep. CFSTI.

A dumping of a batch of radioactive waste from the Nine Mile Point Power Reactor which exceeds Technical Specifications limits is detailed. Causes of the inadvertent release are given. Monthly average and daily average activities are given. Corrective actions are considered briefly. (M.L.S.)

20515 (DOCKET-50220-36) NINE MILE POINT NUCLEAR STATION, UNIT NO. 1. [Temporary Change in Technical Specifications]. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 11 Mar 1970. 4p. Dep. CFSTI.

The cracks in the safe-end of the core spray nozzle in the Nine Mile Point Power Reactor, Unit 1, are described. A request for a temporary change in Technical Specifications to allow lowering of the water level in the reactor to four feet above the fuel is delineated. Methods for control of personnel exposure and water level and for heat removal are outlined. (M.L.S.)

20516 (DOCKET-50244-40) [ROBERT] GINNA STATION, UNIT NO. 1. Excess Leakage in the Containment System. (Rochester Gas and Electric Corp., N. Y.). 13 Mar 1970. 2p. Dep. CFSTI.

Results of pressure testing of the Robert E. Ginna Power Reactor, Unit I, containment air locks are discussed. Test pressures and temperatures are given. Repairs to the penetration shields are described. (M.L.S.)

20517 (DOCKET-50245-14) MILLSTONE NUCLEAR POWER STATION, UNIT 1. [Final Safety Analysis Report], Amendment 14. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Apr. 3, 1968. 184p. Dep. CFSTI.

Stress testing for the jet pumps is described. Stability requirements for piping systems are presented. The auxiliary power system is described. Valve operation for the emergency core cooling system is reviewed. Reactor support structures are illustrated. Stress limits for the support structures are presented. Seismic stresses on reactor systems and structures are analyzed. The waste disposal system is described. Personnel qualifications are reviewed. Emergency procedures for reactor accident conditions are described. (D.C.C.)

20518 (DOCKET-50245-32) [MILLSTONE NUCLEAR POWER STATION, UNIT 1]. Notice of Proposed Issuance of Provisional Operating License and Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 13 Mar 1970. 43p. Dep. CFSTI.

20519 (DOCKET-50250-17) [TURKEY POINT PLANT, UNITS NO. 3 AND 4. [Preliminary Safety Analysis Report], [Amendment 9], Suppl. 9. (Florida Power and Light Co.). 30 Nov 1966. 29p. (DOCKET-50251-16). Dep. CFSTI.

Design specifications for withstanding tornado winds are reviewed. Inspection requirements for containment structure tendons are described. Pipe penetrations for the containment structure are discussed. Stress analysis for the containment structure is presented. (D.C.C.)

20520 (DOCKET-50250-18) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report, [Amendment 10], Suppl. 10. (Florida Power and Light Co.). 9 Dec 1966. 36p. (DOCKET-50251-17). Dep. CFSTI.

Analyses of the Emergency Core Cooling System (ECCS) for the Turkey Point Power Reactor, Units 3 and 4 are given; containment pressure analyses are included for conditions of no core cooling with all the stored heat and with the decay heat and heat from the zirconium-water reaction. Integrity requirements for core and internals are listed; forces and pressures on these components are calculated, in detail, for coolant loss accident conditions. (M.L.S.)

20521 (DOCKET-50250-19) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report, [Amendment 11], Suppl. 11. (Florida Power and Light Co.). 4 Jan 1967. 65p. (DOCKET-50251-18). Dep. CFSTI.

A description and analysis of the emergency core cooling system for the Turkey Point Power Reactor, Units 3 and 4 are given. Seismic design and load factors are detailed; the design spectrum is shown graphically. Detailed data on site meteorology and climatology are included. (M.L.S.)

20522 (DOCKET-50250-20) [TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. [Preliminary Safety Analysis Report], [Amendment 12], Suppl. 12. (Florida Power and Light Co.). 23 Jan 1967. 7p. (DOCKET-50251-19). Dep. CFSTI.

Total plant costs are projected for Turkey Point Power Reactor, Units 3 and 4. Estimates of uranium which will be required for

fuel are listed. The location and topography of the Turkey Point are described briefly. (M.L.S.)

20523 (DOCKET-50250-21) [TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4]. [Preliminary Safety Analysis Report], [Amendment 13], Suppl. 13. (Florida Power and Light Co.). 11 Dec 1967. 27p. (DOCKET-50251-20). Dep. CFSTI.

Hurricane flood protection provisions for the Turkey Point Power Reactor, Units 3 and 4 are detailed. Design criteria are formulated. Results of a detailed model study of wave action at the Turkey Point intake are discussed; data are tabulated. (M.L.S.)

20524 (DOCKET-50250-22) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report, [Amendment 14], Suppl. 14. (Florida Power and Light Co.). 14 Mar 1968. 68p. (DOCKET-50251-21). Dep. CFSTI.

Details relating to the filter system for the Turkey Point Power Reactor, Units 3 and 4 are given. Amounts of iodine which are released from the core under coolant loss accident conditions are postulated; filter decontamination factors and efficiencies are evaluated. Exposure doses are calculated. Integrity of the filter-unit components is assessed. Emergency filter specifications are listed; HEPA and charcoal filter bank specifications are given. Detailed wind speed and direction data are tabulated for the Turkey Point site. A detailed report on methods of iodine removal is included. (M.L.S.)

20525 (DOCKET-50250-23) TURKEY POINT [PLANT], UNIT 3. Report on Honeycombing Containment Mat. (Bechtel Associates, Gaithersburg, Md.). 19 Jul 1968. 111p. Dep. CFSTI.

For Florida Power and Light Co.

Details of the honeycombing of the Turkey Point Power Reactor, Unit 3 containment mat are given. Results of the visual inspection, sonic testing, and coring are described. Factors which contributed to the honeycombing are analyzed; the repair procedures which were used—grouting, dry-pack, and shotcreting—are described. The containment mat structure is analyzed. (M.L.S.)

20526 (DOCKET-50250-24) TURKEY POINT PLANT [UNITS NO. 3 AND 4] ENVIRONS, 1966-1969. Radiological Surveillance Programs. (Florida Power and Light Co.). Jan 1970. 284p. (DOCKET-50251-22). Dep. CFSTI.

20527 (DOCKET-50261-12) H. B. ROBINSON UNIT NO. 2. Preliminary Safety Analysis Report, Amendment 9. (Carolina Power and Light Co., Raleigh, N. C.). Sept. 5, 1969. 201p. Dep. CFSTI.

Revised information on reactor buildings and facilities is presented. Engineered safeguards are described. Quality assurance requirements for reactor systems are reviewed. Design parameters for control elements and fuel elements are revised. Cooling system inspection and testing procedures are described. Containment structures are described. Radioactive waste systems are illustrated. (D.C.C.)

20528 (DOCKET-50261-25) H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2. [Preliminary Safety Analysis Report], Amendment 19 (Includes Final Safety Analysis Report, Amendment 10). (Carolina Power and Light Co., Raleigh, N. C.). 18 Mar 1970. 214p. Dep. CFSTI.

Capability tests for concrete containment structure protective coatings are described. Analysis of boiler tube rupture is presented. Safety limits for the reactor core and cooling system are described. Emergency core cooling system and engineered safeguards operating conditions are analyzed. Inspection schedules and procedures for reactor components are described. Personnel qualifications and responsibilities are listed for plant operation. (D.C.C.)

20529 (DOCKET-50269-12) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. [Preliminary Safety Analysis Report], Amendment 10 (Includes Final Safety Analysis Report, Rev. 3). (Duke Power Co., Charlotte, N. C.). 16 Mar 1970. 164p. (DOCKET-50270-12; DOCKET-50287-9). Dep. CFSTI.

Stress analysis for the cooling system is presented. Design parameters and stress capabilities of the piping system are listed. Inspection procedures for the cooling system are described. Performance requirements of the emergency core cooling system are analyzed. (D.C.C.)

20530 (DOCKET-50302-12) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Preliminary Safety Analysis Report, Amendment 8. (Florida Power Corp., St. Petersburg). 4 Mar 1970. 460p. Dep. CFSTI.

Design parameters and stress analyses for concrete containment structure tendons and anchors are presented. Testing programs for the tendons and anchors are described. Test data are listed. (D.C.C.)

20531 (DOCKET-50313-19) [ARKANSAS NUCLEAR ONE]. Preliminary Safety Analysis Report, [Amendment 16]. (Arkansas Power and Light Co., Little Rock). 9 Mar 1970. 9p. Dep. CFSTI.

Additional information is presented concerning stress analysis of anchorage zone reinforcing steel. (D.C.C.)

20532 (DOCKET-50315-2) DONALD C. COOK NUCLEAR PLANT. Preliminary Safety Analysis Report, Amendment 2, Vol. 4. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). June 14, 1968. 254p. (DOCKET-50316-2). Dep. CFSTI.

Additional information on engineered safeguards is presented. Plant operation requirements are reviewed. Instrumentation for reactor systems is described. Auxiliary power systems are discussed. Qualifications and training requirements for reactor personnel are reviewed. The emergency core cooling system is described. Waste systems are discussed. Radiation monitoring requirements are analyzed. Revised information on plant buildings and facilities is presented. Containment system design parameters are listed. (D.C.C.)

20533 (DOCKET-50315-17) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Construction Permits Nos. CPPR-60 and CPPR-61; Design Changes. (American Electric Power Service Corp., New York). 10 Mar 1970. 5p. (DOCKET-50316-17). Dep. CFSTI.

For Indiana and Michigan Electric Co., Fort Wayne, Ind.

Design changes are presented for containment system charcoal filters, cooling system, and steam generator enclosures. (D.C.C.)

20534 (DOCKET-50321-14) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Supplementary Information to the Preliminary Safety Analysis Report. (Georgia Power Co., Atlanta). 25 Feb 1970. 23p. Dep. CFSTI.

The in-service inspection program for the reactor coolant pressure boundary is presented. Methods, techniques, and procedures for the inspection requirements are described. (D.C.C.)

20535 (DOCKET-50324-15) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. [Inservice Inspection and Containment Dry Well and Torus Pressure]. (Carolina Power and Light Co., Raleigh, N. C.). 11 Mar 1970. 57p. (DOCKET-50325-15). Dep. CFSTI.

20536 (DOCKET-50327-16) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 10. (Tennessee Valley Authority, Chattanooga. Office of Power). 9 Mar 1970. 46p. (DOCKET-50328-16). Dep. CFSTI.

Revised information concerning the containment structures is presented. Design parameters for the emergency core cooling system are included. Flood hazards for the reactor site are analyzed. The auxiliary power system is described. (D.C.C.)

20537 (DOCKET-50333-20) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 4 Mar 1970. 105p. Dep. CFSTI.

For Power Authority of the State of New York.

20538 (DOCKET-50335-13) HUTCHINSON ISLAND PLANT, UNIT NO. 1. [Preliminary Safety Analysis Report], Amendment 8. (Florida Power and Light Co.). 4 Mar 1970. 6p. Dep. CFSTI.

Additional information is presented concerning the possible damage of Class 1 piping systems due to failures of Non-Class 1 piping systems. (D.C.C.)

20539 (DOCKET-50338-15) NORTH ANNA POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 6. (Virginia Electric and Power Co., Richmond). 24 Mar 1970. 40p. (DOCKET-50339-15). Dep. CFSTI.

Operation limitations for engineered safeguards are presented. Personnel responsibilities and qualifications for plant operation are listed. Safety limits for fuel elements are analyzed. The effects of fast neutrons on the pressure vessel are calculated. (D.C.C.)

20540 NUCLEAR PLANTS CAN POLLUTE WATER WITH DISCHARGES OF HEAT AND RADIOACTIVITY. Power; 114: No. 4, 32(Apr 1970).

Hazards involved with power reactor release of thermal effluents and radioactive liquids are described. Possible solutions to the hazards are analyzed. 10 references. (D.C.C.)

20541 COMPARING RADIOACTIVE EMISSIONS. Power; 114: No. 4, 31-2(Apr 1970).

Radioactive emissions from fossil-fueled and nuclear-fueled power plants are analyzed. Comparisons are presented for coal-fired plants, pressurized-water reactors, and boiling reactors in terms of fractions of total dose limits. (D.C.C.)

Power Reactor Development

Refer also to abstracts 19130, 19381, 19396, 19398, 19419, 19420, and 19471.

20542 ANNUAL MEETING ON PERSPECTIVES AND PLANNING OF NUCLEAR POWER PLANTS IN YUGOSLAVIA, BELGRADE, OCTOBER 1968. Nukl. Energ.; 5: No. 3-5, 1-75 (1968-69). (In Serbo-Croatian). (CONF-681079).

Research programs related to the development of power reactors in Yugoslavia are reviewed. Design requirements for heavy-water-moderated, boiling, power reactor systems are analyzed. Separate abstracts are presented for 19 of the 20 papers included. (D.C.C.)

For abstracts of individual papers see: 19446, 20543, 20548, 20550, 20563-20567, 20570-20572, 20574, and 20584-20589.

20543 OPTIMIZATION OF NUCLEAR POWER PLANT PARAMETERS. Jovanic, Milan. Nukl. Energ.; 5: No. 3-5, 6-9 (1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The criteria listed for the optimization of basic nuclear power plant parameters are founded on the technical, economic and safety aspects of the plant. An example was made for a 500 MW boiling heavy water type nuclear power plant. The numerical procedure for the optimization of parameters involves core proportioning, calculation of the necessary fuel, the total amount of water, the proportions of the reactor vessel and the main equipment components. Also, there is the calculation of the plant's working parameters such as moderator and fuel temperature, the volume content of steam in the fuel channel, and fuel burn-up. By way of extra formulas care is taken of the safety aspects with respect to the burn-out of cladding and fuel melting. Depending on the working parameters of the power plant the investments into the plant are being calculated, and also the "present worth" of the power generating costs. The determination of the optimal combination of the basic plant parameters satisfying the set criteria for optimization, is made by aid of another numerical procedure. 4 references. (auth)

Kinetics and Dynamics

Refer also to abstract 20641.

20544 (AI-AEC-12911) LMFBR PHYSICS PROGRAMS. Quarterly Technical Progress Report, October-December 1969. (Atomics International, Canoga Park, Calif.). 15 Feb 1970. Contract AT(04-3)-701. 30p. Dep. CFSTI.

COMPUTER PROGRAMS — VIM-1, debugging of Monte Carlo physics calculations
CRITICAL ASSEMBLIES — control rod cluster in ECEL Core 17, measurement of reactivity worth of tantalum — fuel pin assemblies for ECEL Core 20, fabrication of hexagon shaped stainless steel clad uranium oxide (UO_2)
LIQUID METAL FAST BREEDER REACTOR — physics measurement programs during October to December 1969 — neutron spectra for, computer program calculation of
NEUTRON CROSS SECTIONS — calculation of uranium-235, revision of data library for
NEUTRONS, FAST — spectra in LMFBR, computer program calculation of
NEUTRONS, INTERMEDIATE — spectra in LMFBR, computer program calculation of
REACTOR CONTROL ELEMENTS — reactivity worth of cluster arranged rod type tantalum, measurement of
REACTOR FUEL ELEMENTS — fabrication of ECEL Core 20 hexagon shaped stainless steel clad uranium oxide (UO_2) pin type
TANTALUM — reactivity worth measurement in ECEL core 17
URANIUM ISOTOPES U-235 — neutron cross sections for, revision of data library for calculation of (D.C.C.)

20545 (AI-AEC-12912) LMFBR SAFETY PROGRAMS. Quarterly Technical Progress Report, October-December 1969. (Atomics International, Canoga Park, Calif.). 15 Feb 1970. Contract AT(04-3)-701. 14p. Dep. CFSTI.

AEROSOLS — production of, effects of liquid sodium combustion in LMFBR environment on, (E/T)
LIQUID METAL FAST BREEDER REACTOR — safety programs during October to December 1969
REACTOR SAFETY — coolant combustion for LMFBR, test programs for liquid sodium spray, (E/T)
SODIUM — combustion of sprays of liquid, test programs for, (E/T) (D.C.C.)

20546 IN-CORE MEASUREMENTS IN NUCLEAR REACTORS. Shibata, Toshikazu; Kimura, Itsuro (Kyoto Univ.). Oyo Butsuri; 39: 30-42(Jan 1970). (In Japanese).

The progress in the technique of in-core measurements is reviewed for the following categories: thermal and epithermal neutron spectroscopy in a reactor or in a critical assembly; fast neutron spectroscopy in a reactor or in a critical assembly; neutron flux measurement in an operating power reactor; process instruments in an operating power reactor; and in-pile dosimetry in a reactor. The emphasis is laid on the experiences at the Kyoto University Reactor, KUR. (auth) (NSA of Japan)

Control Systems

20547 (KFK-1048) SHUT DOWN OF A FAST SODIUM-COOLED REACTOR BY MEANS OF ADDITION OF A NEUTRON ABSORBER TO THE COOLANT. Dorner, S.; Schroeter, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Aug 1969. 14p. (In German). (EUR-4312). Dep. CFSTI (U. S. Sales Only).

A theoretical analysis is performed of a Na-cooled fast reactor excursion with core deformation. To achieve a sudden shutdown in such an emergency, addition of Li to the Na coolant appears most suitable and technically feasible. Due to its high neutron cross section, ^6Li must be employed. For the Li-Na alloy the following properties are discussed: rate of mixture, corrosive behavior, and separation of Na and Li. Results of the analysis are summarized in four tables. 10 references. (H.B.G.)

20548 ANALYSIS OF DESIGN SOLUTIONS FOR A NUCLEAR POWER PLANT OPERATING SYSTEM BY USE OF COMPUTERS. Dugic, Borivoje; Radulovic, Predrag. Nukl. Energ.; 5: No. 3-5, 38-43(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The safe and economic operation of a nuclear power plant requires calculations of many processes and nuclear variables. An on-line digital process computer can provide the operating staff with all these data. The application of a digital process computer as used in the 500 MW(e)BHWR is described. 7 references. (auth)

20549 THE LABORATORY FOR REACTOR CONTROL AND SAFETY SYSTEMS. DEVELOPMENT AND TESTING. Bastl, W. (Technische Hochschule, Garching, Ger.). Atomwirt., Atomtech.; 15: 127-30(Mar 1970). (In German).

The historical development of the laboratory for reactor control and safety systems of the Technical University Munich is described for the period from 1963 through 1969. At the present time the department possesses a hybrid system between analog and digital computers that permits the most complex calculation of reactor parameters such as pressure, temperature, cooling fluid, and neutron flux. Presently, analyses of pressurized water power reactors are underway with emphasis on early recognition of mechanical failures and oscillations. (H.B.G.)

Shielding

20550 CALCULATION OF BIOLOGICAL PROTECTION AND DOSE FIELDS IN NUCLEAR POWER PLANT ANCILLARY SYSTEMS. Mandic, Vencel; Vuletic, Velijko. Nukl. Energ.; 5: No. 3-5, 33-4(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The basic principles for defining the source and the method for the calculation of the biological protection, and the determination of dose fields in premises of the ancillary systems in nuclear power plants are presented. The calculation procedure has been programmed for a ZUSE Z-23 computer along with the introduction of certain approximations. Results are analyzed. 4 references. (auth)

Cooling Systems

Refer also to abstracts 19126, 19267, and 20636.

20551 (ANL–7617) OPERATING EXPERIENCE WITH THE EBR-II ROTATING-PLUG FREEZE SEALS. Cooper, Larry P.; Cerutti, Bernard C.; Cissel, Donald W. (Argonne National Lab., Ill.). Dec 1969. Contract W-31-109-eng-38. 47p. Dep. CFSTI.

The EBR-II rotating-plug freeze seals have fulfilled the design requirements of acting as a blanket-gas seal while providing a solid mechanical seal during reactor power runs and providing a movable liquid seal during fuel handling. Problems related to rotating-plug freeze seal development and operation are described. Maintenance requirements are listed. 6 references. (auth)

20552 (APDA–248) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, JULY–SEPTEMBER 1969. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 54p. Dep. CFSTI.

Tube wastage by sodium–water reactions in steam generators is analyzed. Test results for Cr–Mo–steel are presented. Test programs and results for the prototype Rhometer automatic temperature compensator in a liquid Na loop are described. A comparison of methods for calculating and measuring heterogeneity effects in fast reactor critical assemblies and power reactors is presented. 24 references. (D.C.C.)

20553 (TID–25367(Vol.1)) STRENGTH AND BEHAVIOR OF PRESTRESSED CONCRETE VESSELS FOR NUCLEAR REACTORS. Paul, S. L.; Sozen, M. A.; Schnobrich, W. C.; Karlsson, B. I.; Zimmer, Alan (Illinois Univ., Urbana). Jul 1969. Contract W-7405-eng-26; Subcontract 2906. 174p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The structural behavior of prestressed concrete pressure vessels for reactors is investigated. The fabrication and testing to failure of 16 small-scale cylindrical prestressed concrete vessels are described. A mathematical model to stimulate the response of the test vessels is presented. The model uses the lumped-parameter technique. Comparisons of measured and calculated responses are included. (9 references) (D.C.C.)

20554 (TID–25367(Vol.2)) STRENGTH AND BEHAVIOR OF PRESTRESSED CONCRETE VESSELS FOR NUCLEAR REACTORS. Paul, S. L.; Zimmer, Alan; Gotschall, H. L.; Matson, R. H.; Karlsson, B. I.; Mohraz, B.; Schnobrich, W. C.; Sozen, M. A. (Illinois Univ., Urbana). Jul 1969. Contract W-7405-eng-26; Subcontract 2906. 263p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Materials used in the test vessels are described. Fabrication procedures and techniques for the test vessels are included. Instrumentation used on the vessels during testing is discussed. Test data are presented. (D.C.C.)

20555 (UCRL–50647) LITHIUM PROPERTIES RELATED TO USE AS A NUCLEAR REACTOR COOLANT. Cowles, J. O.; Pasternak, A. D. (California Univ., Livermore. Lawrence Radiation Lab.). 18 Apr 1969. 53p. Dep. CFSTI.

Information relevant to the use of Li as a reactor coolant is presented. Topics covered include Li physical and chemical properties, safety and handling consideration, purification and analysis, heat transfer and compatibility with other materials. 121 references. (auth)

20556 GAS PURIFYING EQUIPMENT BY-PASSED WITH THE MAIN CIRCUIT OF A GAS COOLED REACTOR. (to Gutehoffnungshuette Sterkrade Aktiengesellschaft). French Patent 1,545,992. 7 Oct 1968. Priority date 29 Nov 1966, Germany. (In French).

REACTORS, GAS-COOLED—coolant for, description of primary-loop-bypass purification loop for (M.L.S.)

20557 LIQUID-COOLED NUCLEAR REACTOR. Leclou, Andre (to Commissariat a l'Energie Atomique). British Patent 1,184,121. 11 Mar 1970. Priority date 28 Mar 1967, France.

HEAT TRANSFER SYSTEMS—design parameters of liquid metal cooled reactor triple tank contained

REACTORS, LIQUID METAL-COOLED—cooling system for, design parameters of triple tank contained (D.C.C.)

20558 PROCEEDINGS OF THE SECOND CANADIAN CONGRESS OF APPLIED MECHANICS, WATERLOO, ONTARIO, MAY 1969. Waterloo, Ont.; University of Waterloo (1969). 491p. (CONF-690547).

Topics discussed are grouped into three main headings: mechanics of fluids; mechanics of solids; and heat transfer. Of the 220 papers in the conference separate abstracts are included for five papers on the topic of fluid flow in reactor cores. (D.C.C.)

For abstracts of individual papers see: 20559–20562 and 20651.

20559 DOWNFLOW THERMOSYPHONING IN A NUCLEAR REACTOR. Barns, G. M.; Rogers, J. T. (Atomic Energy of Canada Ltd., Peterborough, Ont.). pp 241-2 of Proceedings of the Second Canadian Congress of Applied Mechanics, Waterloo, Ontario, May 1969. Waterloo, Ont.; Univ. of Waterloo (1969).

See CONF-690547.

A nuclear power reactor system has been proposed with vertical downflow of the pressurized heavy water coolant through the core. Such downflow of the coolant allows the on-power refuelling arrangement to be made simpler, more reliable and less costly. A design criterion for Canadian reactors is that thermosyphoning-induced flows should be adequate to remove fission-product decay heat during reactor shutdown. Thermosyphoning will maintain downflow when this flow direction has been initially established by the pumps. The pressure-drop/flow characteristic of the downflow core passes through a minimum value at a finite low flow for a typical reactor at 5% power. Stable downflow can be maintained only at flows higher than the value at the pressure drop minimum. Such flows are produced only if the top of the heat exchanger is more than five feet above the top of the reactor. Analysis thus far has shown that shutdown cooling of a vertical reactor with thermosyphoning-induced downflow is feasible. (F.S.A.)

20560 FLOW OSCILLATION IN A CHANNEL HEATED BY 19-ROD BUNDLES WITH AN UNHEATED BYPASS. COMPARISON OF ANALYTICAL PREDICTIONS WITH EXPERIMENTAL DATA. Hancox, W. T. (Canadian Westinghouse Co., Hamilton, Ont.); Nicoll, W. B. pp 247-8 of Proceedings of the Second Canadian Congress of Applied Mechanics, Waterloo, Ontario, May 1969. Waterloo, Ont.; Univ. of Waterloo (1969).

See CONF-690547.

Current use of models as design tools in reactor cooling technology is examined. Analytical models are derived starting with the conservation laws which yield a set of four non-linear equations. The equation of state is specified resulting in a fifth equation. Solutions are sought with constant channel pressure drop and inlet temperature conditions. All models seek a "stability threshold," i.e., the flow conditions beyond which a single perturbation (usually a step in heat flux) from the steady state will result in either sustained or unbounded oscillations. The SWIFT loop which is described was used for the investigations. Experimental conditions comprise systematic variation of: the test section and bypass flow rates, test section pressure, inlet subcooling, and inlet and effluent feeder pressure drops. (F.S.A.)

20561 HYDRODYNAMIC INSTABILITY IN A FULL SCALE SIMULATED REACTOR CHANNEL. Collins, D. B.; Gacesa, M. (Canadian Westinghouse Co., Hamilton, Ont.). pp 251-2 of Proceedings of the Second Canadian Congress of Applied Mechanics, Waterloo, Ontario, May 1969. Waterloo, Ont.; Univ. of Waterloo (1969).

See CONF-690547.

When a large number of heated flow channels are operated in parallel with each other, between common inlet and outlet headers, all channels will see the same differential pressure. Moreover, if a flow disturbance occurs in one or a few of the channels, the flow will be redistributed among the other channels and the inlet header to outlet header pressure drop will remain essentially unchanged. With this constant pressure drop and for a particular geometry, heat flux, channel flowrate etc., a resonance condition may occur in which the initial channel disturbance gives rise to a sustained channel flowrate oscillation. The experimental program, results and tentative conclusions are outlined. (F.S.A.)

20562 MEASUREMENT OF DRYOUT DISTRIBUTIONS IN SIMULATED REACTOR COOLANT CHANNELS. Hancox, W. T. (Canadian Westinghouse Co., Hamilton, Ont.); Nicoll, W. B.; Stern, F. pp 261-2 of Proceedings of the Second Canadian Congress of Applied Mechanics, Waterloo, Ontario, May 1969. Waterloo, Ont.; Univ. of Waterloo (1969).

See CONF-690547.

Experiments were conducted on the SWIFT experimental loop facility operated for Atomic Energy of Canada Limited. A channel operating with subcooled two-phase inlet conditions was simulated. The results show that there are substantial asymmetries in individual element power at dryout, and hence presumably also in phase, velocity and enthalpy distributions. The rotation tests indicate that these asymmetries must be attributed to inlet and exit effects and not to any asymmetries in the bundle, even though the critical plane was approximately 150 hydraulic diameters from the inlet and exit piping. The lack of symmetry with respect to

the orientation of either the inlet or effluent piping indicates both may contribute to the observed effects. (F.S.A.)

20563 THE THERMAL AND HYDRAULIC CHARACTERISTICS OF BHW TYPE REACTORS. Mesarovic, Miodrag; Radulovic, Predrag. Nukl. Energ.; 5: No. 3-5, 10-13(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

A steady state heat transfer and a hydraulics code for a BHWR natural circulation pressure vessel and a PRETOR-6 computer program are presented. The code is made practical from the engineers point of view so as to meet the particular requirements concerning extensive reactor design studies. The program contains cosine axial power distribution, while that in the radial direction may be chosen arbitrarily. It calculates thermal and hydraulics performances of both reactor and individual fuel channels at various coolant distribution alternatives over the core. Boundary condition concerning fuel melting, static burnout, water carry-over and steam carry-under are calculated and working conditions checked against them simultaneously. 13 references. (auth)

20564 CHOICE OF COOLING WATER DESIGN TEMPERATURE. Popovic, Aleksandar. Nukl. Energ.; 5: No. 3-5, 23-5 (1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The procedure is described for choosing the most convenient design temperature of the cooling water for a thermal power condensation plant with open circuit cooling depending on the manner in which the passage of the cooling water is being regulated. An example was given for a chosen site. 3 references. (auth)

20565 DECREASE IN THE LOSS OF HEAVY WATER BY GAS DRYING. Milosevic, Radoslav; Sivjakov, Vladimir; Kosaric, Namik. Nukl. Energ.; 5: No. 3-5, 44-6(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The procedures for drying radioactive gases are reviewed. The technical and economic factors related to optimizing the system are analyzed. 7 references. (auth)

20566 WATER REGIME OF NUCLEAR POWER PLANTS. Milosevic, Radoslav; Grbin, Jasna; Sivjakov, Vladimir; Jaksic, Branko. Nukl. Energ.; 5: No. 3-5, 50-2(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The methods for analyzing the quality of the water in the cooling circuit of a nuclear power plant are described. The method for calculating the yields, concentrations, activation, and the distribution of corrosion products in a BHWR type nuclear power plant primary circuit for a balanced activation-corrosion system in normal operating conditions is analyzed. For the calculation method a programme was prepared for the ZUSE Z-23 and GAMMA 30 type computer, and the results obtained serve for the determination of the design foundations of a system for maintaining the quality of the water. 2 references. (auth)

20567 PROCEDURES FOR HEAVY WATER RECONCENTRATION. Milosevic, Radoslav; Kosaric, Namik. Nukl. Energ.; 5: No. 3-5, 53-4(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The procedures for the enrichment of heavy water are reviewed. The procedure suiting best the conditions for building it into a nuclear power plant is analyzed. Design and development programs required for the design and the fabrication of the plant are described. 7 references. (auth)

Fuels

20568 (JUL-618-RB) INVESTIGATION OF INNER AND OUTER RIBBED, TUBULAR GAS-COOLED FUEL ELEMENTS. Presser, K. H.; Harth, R.; Broeckerhoff, P. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Oct 1969. 74p. (In German). Dep. CFSTI (U. S. Sales Only).

Cladding tubes with horizontal, vertical, and angular ribbing are studied with respect to local heat conduction and pressure changes for natural uranium fueled graphite-moderated gas-cooled reactors. The cooling gas internal and external turbulent streams are theoretically calculated and experimentally verified. Highest heat transfer is reached with inner and outer angular ribs. However, an 11% smaller heat transfer is achieved with longitudinal ribs. Considering that gas stream resistance is lower and manufacturing costs are considerably less than those for angular ribs, it is concluded that longitudinal ribs are economically competitive with angular ribbed tubings. 26 references. (tr-auth)

20569 (WAPD-TM-652) AN ANALYSIS OF TRANSIENT CLAD STRAINS IN CYLINDRICAL FUEL ELEMENTS INCLUDING THE EFFECTS OF OXIDE PELLET CRACKING (STRIPE). LWBR Development Program. O'Donnell, W. J.; Clarke, W. G.; Campbell, W. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb 1970. Contract AT(11-1)-Gen-14. 58p. Dep. CFSTI.

An analysis of the deformations imposed on the cladding of cylindrical fuel elements by differential thermal expansions during an abrupt reactor power increase is presented. The effects of pellet cracking are included in the analysis and are found to be very significant. The analytical model also includes the effects of temperature-dependent material properties, possible pellet-to-cladding gaps, compressive plastic flow in the hot inner core of the pellet, and tensile yielding of the cladding. The solution was programmed in FORTRAN IV for the CDC-6600 digital computer as STRIPE (MO650). Calculated results are compared with experimental results obtained on UO_2 fuel rods irradiated at Chalk River. Good agreement was found over a very wide temperature range. (16 references)

20570 ANALYSES OF FUEL DISCHARGE PROCEDURES. Jaksic, Branko. Nukl. Energ.; 5: No. 3-5, 14-17(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

A review of activities on the analysis of fuel discharge schemes in thermal reactors is presented. Initial work indicated the necessity of preparing a program specialized for this type of analysis. The ROTOR Program, prepared in 1966, is described. The program has been used for the analysis of the transient regimes in BHW reactors. An analytical procedure has been elaborated based on the material balance of fuel taking into account the limitations imposed by the geometrical system and the capacity of the fuel discharge machine. The calculations have shown that before arrival to the set regime one has to leave the planned scheme in order to increase the relation between medium burn-up in the peripheral and the central reactor zone. To achieve this a procedure has been proposed which anticipates a successive shift of the fuel from the central to the peripheral zone, and the addition of fresh fuel elements into the central zone. 4 references. (auth)

20571 FUEL DISCHARGE MANIPULATOR FOR BHW TYPE REACTORS. Skolnik, Ivan; Zake, Geza. Nukl. Energ.; 5: No. 3-5, 63-6(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The specific problems in the construction and the technology of manufacturing the gravitation grab, and the construction problems of the mechanism for operating the manipulator and the grab in the system of fuel discharge in a 1000 to 1500 MW BHWR are described. The specific character of the tong and the operating mechanism is that it works continually in the steam of heavy water at temperatures of about 260°C, without lubricating the mobile parts. Both the tong and the whole of the operating mechanism are made of stainless steel. The mechanism is actuated by electromotors placed outside the reactor vessel. (auth)

Auxiliary and Emergency Systems

20572 VENTILATION OF NUCLEAR POWER PLANT PREMISES. Milosevic, Radoslav; Sivjakov, Vladimir; Ivanovic, Svetlana; Vuletic, Veljko; Kosaric, Namik. Nukl. Energ.; 5: No. 3-5, 47-9(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

Analytical methods for determining the number of changes, the time of the duration of ventilation, and the changes in the volume activity in the premises ventilated are presented. The calculation method was programmed for a ZUSE Z-23 computer. The data obtained serve for the definition of design requirements for the ventilation of premises in heavy water reactor nuclear power plants. 3 references. (auth)

Operation and Economics

Refer also to abstracts 20608 and 20617.

20573 (DOCKET-50018-22) VALLECITOS BOILING WATER REACTOR (DEACTIVATED). Annual Report No. 5. (General Electric Co., Pleasanton, Calif.). 20 Feb 1970. 7p. Dep. CFSTI.

20574 OPERATING PERFORMANCES OF NUCLEAR POWER PLANTS. Jovanovic, Milos. Nukl. Energ.; 5: No. 3-5, 35-7(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

Availability, flexibility and the minimum power output are considered as the most important operating performances of a nuclear power plant relating to a power grid. These performances are discussed in detail. The performances of the various types of nuclear power plants are reviewed. Only the GCR, AGR, PWR, BWR, PHWR, SGHWR and BHWR plants are taken into consideration. In spite of the fact that the experience and understanding of the studied problem is incomplete, mainly due to economic reasons, it has been shown that most of the plants possess outstanding dynamic properties and that all of them have an availability of over 90%. (auth)

20575 MANAGEMENT OF THE AVR TEST REACTOR IN THE YEAR 1969. Atomwirt., Atomtech.; 15: 147(Mar 1970). (In German).

The AVR, the first test reactor in the world with spherical fuel elements, started operation in December 1967. Since that time 116 million kWh of electricity were produced. In 1969, a test of all components was performed. The results showed a smaller radioactive contamination than expected, a less difficult handling of used fuel elements and reactor components that had contact with radioactive gas, and a decrease in contamination of the primary cooling gas. Maximum power was 50 MW(t) and 15.6 MW(e). The two year experience with the test reactor clearly proved its reliability and its suitability for further development into a nuclear power station with higher output. (H.B.G.)

Safety and Siting

20576 (DOCKET-50231-32) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR (SEFOR). [Facility Description and Safety Analysis Report], Amendment 29. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 27 Mar 1969. 3p. Dep. CFSTI.

Specifications for sources request are listed. Sources and quantities include: ^{85}Kr(10mCi); ^{131}I(10mCi); ^{140}Ba(10mCi); ^{140}La(10mCi); ^{137}Cs(10mCi); ^{133}Xe(10mCi); ^{244}Cm(10mCi). (D.C.C.)

20577 (DOCKET-50231-33) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR (SEFOR). [Facility Description and Safety Analysis Report], Amendment 30. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 16 May 1969. 4p. Dep. CFSTI.

Modifications in the sources request are listed. Sources and quantities include: ^{85}Kr(10mCi); ^{131}I(10mCi); ^{133}Xe(10mCi); and ^{137}Cs(10mCi). (D.C.C.)

20578 (IN-1355) SECHT III: AN EXPERIMENTAL INVESTIGATION OF TOP AND BOTTOM FLOODING OF A NUCLEAR BUNDLE SIMULATOR. Moser, C. M.; Griebe, R. W. (Idaho Nuclear Corp., Idaho Falls). Feb 1970. Contract AT(10-1)-1230. 112p. Dep. CFSTI.

The Scoping Emergency Cooling Heat Transfer (SECHT) Project was an experimental project directed at scoping the parameters of bottom and top flooding modes of emergency core cooling for nuclear reactor fuel bundles. The SECHT Project consisted of four series of tests of which the third series (SECHT III tests) is described. The primary objective of the SECHT III tests was to perform timely sensitivity studies by using readily available hardware. Exact scaling of a segment of a reactor core was not accomplished; therefore, the results presented are more qualitative than quantitative. The SECHT III testing program consisted of 55 experiments that were designed to form a parametric study over the range of variables thought possible at the initiation of the emergency core coolant injection in contemporary water cooled reactors. The test parameter variations included: initial bundle temperatures between 800 and 2000°F, cold flooding rates between 0.45 and 7.2 in./sec, average bundle power between 0 and 15,000 Btu/hr-ft^2, and coolant inlet temperatures between 100 and 200°F. The test vessel was fitted with a constrictive device which was placed over the exit as a means of providing preliminary data on the effects of water carry-over. Specific results show that the arrest and turnaround of the bundle temperature excursion occurs more quickly in tests which have high initial temperatures and that the sensitivity of turnaround time to bundle power decreases with increasing bundle initial temperature. The effect of the constriction is shown to be strongly dependent on flow rate. The experience gained from this project in electric heater design, instrumentation, and test procedures has been valuable to the Full Length Emergency Cooling Heat Transfer (FLECHT) Project. 3 references. (auth)

20579 (NP-18150) REPORT ON THE SAFETY ANALYSIS OF THE FAST SODIUM-COOLED REACTORS. Gast, K.; Keller, K.; Peppler, W.; Schikarski, W.; Schlechtendahl, E. G.; Schultheiss, G. F.; Wild, H. (Kernforschungszentrum, Karlsruhe (West Germany)). Aug 1969. 37p. (In German). Dep. CFSTI (U. S. Sales Only).

Failure propagation and accidents in fast sodium cooled fuel elements are discussed. Methods by which failure propagation occurs are considered. Effects of the sodium coolant boiling in-core are analysed; sodium boiling experiments for determining thermodynamic and neutronics behavior are described. Radioactivity release under accident conditions in a sodium cooled fast reactor is evaluated; aerosol and particulate generation and transport under accident conditions are analysed. Incipient and pool boiling mechanisms are discussed; effects of sodium vapor formation are considered. (21 references) (M.L.S.)

20580 (NP-18160) LOSS AND DAMAGE IN NUCLEAR POWER PLANTS: AN INITIAL ANALYSIS BY INSURANCE UNDERWRITERS. A METHOD OF CALCULATING THE SYSTEM RELIABILITY. Feldmann, J.; Renk, K.-D. (Allianz Versicherungs A. G., Munich (West Germany)). Dec 1969. 21p. (In German). Dep. CFSTI (U. S. Sales Only).

Operations histories of power reactors around the world are characterized by reactor type and according to systems failures such as cooling system and pressure vessel, turbines, and whole plant. Property damage caused by failures of fuel and control rods, pressure vessel, heat exchangers, and pumps and valves is discussed; severity of damage is shown graphically. Failure with causes and results are tabulated for: Agesta, Berkeley, Big Rock Point, BONUS, BR-5, Bradwell, Calder Hall, CANDU, Chapelcross, CVTR, Dounreay, EDF-1, EDF-2, EDF-3, EL-4, Elk River, Fermi Fast Breeder, Trino, G-1, G-2, G-3, Garigliano, Hallam, Hinkley Point, Humboldt Bay, Indian Point-1, Tokai Mura, JPDR, Kahl, KRB, Latina, MZFR, NPD, Oldburg, Pathfinder, Peach Bottom-1, Piqua, San Onofre, SENA, Trawsfynydd, and Yankee. A method for calculating systems reliability is described. The method is based on a statistical evaluation of mean-time-between-failure data. Expressions for single-accident probability calculations are given; matrices are constructed for system components. (72 references) (M.L.S.)

20581 (ORNL-TM-2829) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR NOVEMBER-DECEMBER 1969. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 156p. Dep. CFSTI.

ATOMIC ENERGY, LEGAL ASPECTS—development of RDT standards
CESIUM ISOTOPES—release during failure of TRISO coated uranium oxide (UO_2) fuel particles
CESIUM ISOTOPES Cs-137—release from coolant loss actuated failure of Zircaloy clad uranium oxide (UO_2) rod type fuel elements
CHARCOAL—combustion of, effects of fission product decay heat on
DATA ACQUISITION SYSTEMS—operation of Nuclear Safety Information Center, during November to December 1969
FISSION PRODUCTS—release from coolant loss actuated failure of Zircaloy clad uranium oxide (UO_2) rod type fuel elements
GRAPHITE—corrosion by steam, (E/T)
ICE—sorption properties for elemental iodine and methyl iodide
INFORMATION CENTERS—operation of Nuclear Safety, during November to December 1969
IODINE—removal by NSPP basic borate spray system, (E/T)
—sorption on metal surfaces of high temperature gas cooled reactor cooling system
—sorption properties of ice for
IODINE ISOTOPES I-131—release from coolant loss actuated failure of Zircaloy clad uranium oxide (UO_2) rod type fuel elements
METHANE, IODO—sorption on ice
NOZZLES—stresses in multiple and single cylindrical and spherical shell connected, effects of configuration on
NUCLEAR SAFETY PILOT PLANT—removal of elemental iodine by basic borate spray, (E/T)
PIPE FITTINGS—stress analysis of ASA B16.9 tees, (E)
REACTOR FUEL ELEMENTS—failure of TRISO coated uranium oxide (UO_2), measurement of cesium release during
—failure of Zircaloy clad uranium oxide (UO_2) rod type, fission product release for coolant loss actuated
—swelling of Zircaloy clad rod, effects of coolant loss conditions on

REACTOR SAFETY—research and development program during November to December 1969, analysis of ORNL
REACTORS, GAS-COOLED—cooling system for high temperature, adsorption of iodine on metal surfaces of
REACTORS, POWER—cooling system for high temperature gas cooled, adsorption of iodine on metal surfaces of
SODIUM THIOSULFATE—decomposition of, analysis of sulfur formation from radiolytic
SPRAYS—effectiveness of NSPP basic borate, for removal of elemental iodine, (E/T)
STANDARDS—development of RDT
STEAM—corrosive effects on graphite, (E/T)
STEEL—tensile properties of A533 HSST, (E)
SULFUR—formation of, effects of radiolytic decomposition of sodium thiosulfate on
TELLURIUM ISOTOPES Te-129—release from coolant loss actuated failure of Zircaloy clad uranium oxide (UO_2) rod type fuel elements
ZIRCALOY—mechanical properties at high temperatures of, measurement of (D.C.C.)

20582 WATER LEAK DETECTORS. (to Atomic Energy of Canada Ltd.). British Patent 1,184,603, 18 Mar 1970. Priority date 29 Jul 1966, Canada.

LEAK DETECTORS—design parameters of water cooled reactor cooling system strontium chromate ($SrCrO_4$)/silver sulfate (Ag_2SO_4) couple
REACTORS, WATER-COOLED—cooling system of, description of strontium chromate ($SrCrO_4$)/silver sulfate (Ag_2SO_4) couple leak detector for
SILVER SULFATES—$Ag_2SO_4/SrCrO_4$, use for water cooled reactor cooling system leak detector
STRONTIUM CHROMATES—$Ag_2SO_4/SrCrO_4$, use for water cooled reactor cooling system leak detector (D.C.C.)

20583 PROBLEMS OF LEGISLATION IN THE FIELD OF CIVIL APPLICATIONS OF NUCLEAR ENERGY. Domsdorf, E. P. M. W. Electrotechniek, 47: 209-16(May 1, 1969). (In Dutch).

The history of nuclear legislation is briefly described, pointing out the necessity for international control. The Netherlands are presently involved in 15 treaties and organizations. The specific problems of national nuclear legislation include the following: safety standards must be established to protect industrial workers and the population at large; safeguards and controls must be set up against the military use of radioactive materials; storage and transportation of fuels and ores must be subject to preventive measures, such as registration and licensing. (TTT)

20584 DESIGN CRITERIA FOR THE ENGINEERED SAFEGUARDS IN BHWR's. Mesarovic, Miodrag. Nukl. Energ.; 5: No. 3-5, 18-22(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

General aspects of the engineered safeguards in present BHWRs and a mathematical model for analyzing reactor accidental transients are briefly summarized. Then, based on the safety criteria and a quantitative analysis of different transient conditions, particular design criteria for the main safeguards in a BHWR 500 MW nuclear power plant design are discussed. 6 references. (auth)

20585 BASIC DESIGN CRITERIA FOR HWR's TO BE BUILT ON SEISMIC GROUND. Lubardic, Nikola; Letrovic, Bosko. Nukl. Energ.; 5: No. 3-5, 26-8(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

Influence of earthquakes on safe operation of nuclear power plants has been studied. A general review of design criteria in the field of engineering seismology and aseismic constructions has been given, with particular reference to the influence of earthquakes on nuclear power plants. Design requirements for mechanical equipment in HWR nuclear power plants are presented. 8 references. (auth)

20586 ANALYSIS OF PARAMETERS OF A SYSTEM FOR PRESSURE DAMPING IN BHW REACTORS. Kontic, Branislav. Nukl. Energ.; 5: No. 3-5, 29-32(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

Design parameters for pressure suppression systems of BHWRs are calculated. The calculations are made with a digital computer after a given algorithm. 5 references. (auth)

20587 PRELIMINARY ANALYSIS OF THE RADIOACTIVE EFFULENT DISCHARGE FROM NUCLEAR POWER PLANTS. Rutar, Danilo. Nukl. Energ.; 5: No. 3-5, 55-8(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The method for estimating the maximum effluent discharge is described. The method is based on the relationship between activity concentration of the discharged waste water and the expected annual doses to persons due to the different types of river water utilization. The method applied on the preliminary data for proposed sites in Yugoslavia gives results suitable for their comparison. 2 references. (auth)

20588 INFLUENCE OF THE SITE ON THE DESIGN AND THE SAFETY OF THE NUCLEAR POWER PLANT. Bernot, Natan; Gabrovsek, Zdravko; Grgic, Milan; Susnik, Janez. Nukl. Energ.; 5: No. 3-5, 67-71(1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The relation of reactor design to siting is evaluated. The release of the radioactive products during accidents is estimated taking into account consequence-limiting systems such as reactor protective systems and containment systems. The consequences of radioactive product release in the atmosphere are evaluated. The reference reactor is a 340 MW HWR, and the reference site is Videm Krško. 16 references. (auth)

20589 CRITERIA AND PRINCIPLES OF NUCLEAR POWER PLANT LOCATION. Veljkovic, Tomislav; Jovic, Branko; Mitrovic, Srdan; Petrovic, Slavoljub. Nukl. Energ.; 5: No. 3-5, 72-5 (1968-69). (In Serbo-Croatian).

From Annual Meeting on Perspectives and Planning of Nuclear Power Plant, Belgrade, Yugoslavia. See CONF-681079.

The similarity and the specific dissimilarities of accidents in conventional and nuclear plants are analyzed. Principles of analyzing accidents and of preparing safety documents are described. The basic protective measures against dangers to the plant environment are reviewed. The most vital elements related to the siting of the plant include: geographic position, geologic, hydrologic and seismic conditions, meteorological conditions, population and the other elements of environment. The basic design values (from the recommendations of the International Atomic Energy Agency, or from the practice of the developed countries) used in evaluating the feasibility of sites are described. (auth)

20590 ICE CONDENSER REACTOR CONTAINMENT SYSTEM. Weems, S. J.; Lyman, W. G.; Haga, P. B. Nucl. Eng. Int.; 15: 47-51(Jan 1970).

The concept of using ice as a heat sink capable of absorbing energy which has been accidently released from pressurized water reactors is described. The development of the ice condenser, its performance characteristics, and its application in the containment systems of the Donald C. Cook and the Sequoyah nuclear plants are discussed. Safety features and economic advantages are considered. (UK)

20591 THE RUPTURE OF AN EXTERNAL STEAM-PIPE AS DESIGN CRITERIUM FOR STEAM-COOLED POWER REACTORS. Eisner, J. H. Atompraxis; 16: 28-31(Jan-Feb 1970). (In German).

The additional stresses in the built-in parts of the core by rupture of an external steam-pipe are discussed and a possibility is shown how these additional loads can be eliminated. The necessary design methods and the results for a typical example are given. 2 references. (auth)

20592 ON THE SAFETY ANALYSIS OF NUCLEAR POWER PLANTS. DEFINITIONS WITH PERTURBATION- TIME-DEPENDENT FUNCTION-GROUP MODEL. Ditterich, K. (CCR-EURATOM, Ispra, Italy). Atomwirt., Atomtech.; 15: 135-9 (Mar 1970). (In German).

Aspects of reactor safety are discussed. The concept of Maximum Credible Accidents is based on oversimplifications and neglects disturbances on a smaller scale. It is attempted to approach the problem more methodically with perturbation-time-dependent functions. For safety reasons the total reactor should be subdivided into functional groups, for each of which disturbances can be assessed reasonably well. (H.B.G.)

20593 THE CALCULATIONAL MODEL BRUCH FOR WATER COOLED REACTORS. FOR ANALYSIS OF THERMAL-HYDRAULIC PROCESSES DURING SEVERE TRANSIENTS. Karwat, H. (Technische Hochschule, Garching, Ger.). Atomwirt., Atomtech.; 15: 130-2(Mar 1970). (In German).

To avoid serious accidents, failures in the primary cooling systems of boiling water and pressurized water reactors must be detected immediately for triggering of an auxiliary cooling circuit. The BRUCH computer program permits calculation of various pa-

rameters in several sections of the reactor under simulated failure of pump, tubes, and pressure vessels. Comparison of calculated values with experimental data obtained from the model of a boiling water reactor and those of the LOFT reactor shows discrepancies occurring within the first milliseconds, which are caused by bubble formation and boiling delay. An attempt is made to improve the computer program in such a way that the initial effects are properly assessed. (H.B.G.)

20594 PHILOSOPHY OF REACTOR SAFEGUARDS. DETERMINISTIC FACTORS AND PROBABILITY THEORY OF REACTOR SAFETY. Merz, L. (Technische Hochschule, Munich). Atomwirt., Atomtech.; 15: 118-26(Mar 1970). (In German).

Reactor accidents are caused by two types of events: Recognizable causes, such as errors in planning, miscalculations, and errors in servicing. These can be avoided by proper testing and surveillance. The second type of failure is caused by probability and has no apparent reason; it is well known in aerodynamic and space projects. Although many data about life expectancy of reactor components are still missing, preliminary probability calculations lead to the conclusion that a serious reactor accident because of total failure of the safeguard system will occur once in a period exceeding 100 times the present age of our planet. Thus, only deterministic factors enter into safety considerations. Several methods to minimize these factors are discussed. (H.B.G.)

Power Conversion Systems

20595 (ANL-7600) EVALUATION OF POTENTIAL TUBE VIBRATION IN EBR-II STEAM SUPERHEATERS AND EVAPORATORS AT FULL POWER. Wambsganss, Martin W. Jr. (Argonne National Lab., Ill.). Nov 1969. Contract W-31-109-eng-38. 42p. Dep. CFSTI.

An analytical evaluation of the EBR-II steam superheaters and evaporators was performed to determine the potential for detrimental flow-induced tube vibrations at current operating power (45 MW(t)) and at design power (62.5 MW(t)). Based upon state-of-the-art technology, the evaluation included analyses and discussions of resonant vibration induced by cross flow; hydroelastic instabilities due to parallel flow; baffle design and orientation in the flow field; and tube-baffle impact and its effect on vibrational characteristics and response of the tubes. 19 references. (auth)

20596 METHOD AND APPARATUS FOR GENERATING STEAM. Vuia, Romul Eugen (to Combustion Engineering-Superheater Ltd.). British Patent 1,181,002. 11 Feb 1970. Filed 28 Feb 1967.

Reference is made to means for obtaining and using superheated steam in nuclear power plants. The object of the system described is to provide an inexpensive superheater having a low pressure drop and safe metal temperatures and to provide a power plant which will produce power at less cost. A steam flow is established using nuclear fuel and a second steam flow is simultaneously produced in a fossil fuel fired steam generator. The first steam flow is passed in heat exchange relationship with the combustion products of the fossil fuel fired generator to superheat this first steam flow. The second steam flow may likewise be subjected to a similar heat exchange. Various alternative arrangements of such a system and its power plant applications are described. The power plant may have a multi-section turbine having a section designed exclusively for superheated steam, with means for bypassing this section and introducing bypassed lower temperature steam into the remaining turbine sections. Means may also be provided for sensing the steam temperatures and varying the recirculation of combustion products in response to this sensing means. (UK)

Research and Test Reactors

Refer also to abstracts 19044, 19255, 20598, and 20599.

20597 (DOCKET-50184-4) [NATIONAL BUREAU OF STANDARDS REACTOR]. Preliminary Hazards Summary Report, Suppl. A. (National Bureau of Standards, Washington, D. C.). Apr. 1, 1961. 16p. Dep. CFSTI.

Coolant void control and emergency shutdown of the NBS Research Reactor are discussed. Emergency cooling systems for the core, test facilities, and pressure vessel are described. Waste control and area monitoring are discussed. (M.L.S.)

20598 (EIR-150(Pt.1)) FUEL ELEMENT DEFECTS AND DECONTAMINATION OF THE DIORIT REACTOR. PART I. Brandt, F. C.; Flury, H.; Frick, U.; Suter, F. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Sep 1969. 71p. (In German). Dep. CFSTI (U. S. Sales Only).

On October 11, 1967, one fuel element of the reactor DIORIT suffered severe damage that produced extensive contamination of the reactor tank and the primary cooling circuit with fission products and uranium. After one year, the reactor was placed into operation again. Reasons for the fuel element defect, a rupture of the 2 S aluminum cladding, were studied. Extensive decontamination procedures were performed. Protective measures for personnel participating in the decontamination were developed for various phases of the procedure. During the entire restoration period, nine persons received external doses from 3.5 to 3.8 rem. A few individuals showed tritium incorporation that was below $\frac{1}{5}$ of the permissible body burden. (H.B.G.)

20599 (EIR-150(Pt.2)) FUEL ELEMENT DEFECTS AND DECONTAMINATION IN THE DIORIT REACTOR. PART II. Schenker, E. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). Sep 1969. 44p. (In German). Dep. CFSTI (U. S. Sales Only).

Following the fuel element rupture in the DIORIT reactor, three procedures were performed: decontamination of the reactor components by chemical means, removal of the radioactive material, and testing of the components for corrosion. Uranium dioxide was easily soluble in a solution of 0.1 Mol sulfuric acid with 0.1 Mol hydrogen peroxide that caused only moderate corrosion of Peraluman 35. From the solution, uranium was extracted by ion exchange. Good results for removal of fission products were obtained with a solution consisting of 0.1 Mol sulfonic acid/0.1 Mol chromic acid/0.02 Mol sodium fluoride. The solution containing the fission products was stored in plastic containers that proved quite effective. Some of the fission product containing solution was concentrated and solidified with cement. Corrosion effects were severe on the water conductor tubings, especially on welded seams. Otherwise the reactor components were little affected by corrosive action of the decontaminating solution. (H.B.G.)

20600 (FMRB-1/70) ELECTRICAL EQUIPMENT OF THE BRAUNSCHWEIG RESEARCH AND TESTING REACTORS OF THE FEDERAL PHYSICAL-TECHNICAL INSTITUTE. Runge, E.-G. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). Jan 1970. 92p. (In German). Dep. CFSTI (U. S. Sales Only).

The core configuration of the Research Measuring Reactor (FMRB) consisting of two loosely coupled fission zones or reactor cores requires two identical groups of neutron measuring channels. In each group there is one logarithmic pulse-channel and one linear DC-channel with switchable measuring ranges, whereas the logarithmic DC-channel and the linear DC-channel with one fixed measuring range acting on the safety circuits during normal reactor operation are installed threefold. The function of these tripled measuring channels is controlled by comparison of their output signals. Reactor protection being part of the safety system of the reactor is performed by two-out-of-three-coincidence circuits. Deviations from normal working condition of important operating valves are signalled by means of a danger monitoring device. Schematic diagrams are given to show the functions of various loops (coolant loops, auxiliary loops, ventilation installations, heavy-water system) and the corresponding control points for temperature, flow, activity, etc. 55 references. (auth)

20601 (GEAP-13565) SEFOR FUEL HANDLING. Johnson, M. L.; Becker, R. A.; Haar, J. M. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Dec 1969. Contract AT(04-3)-540. 32p. Dep. CFSTI.

Frequent fuel loading, removal, cleaning, examination and storage operations are necessary to support the planned program in the Southwest Experimental Fast Oxide Reactor (SEFOR). A refueling cell above the reactor vessel contains special equipment designed to perform these operations. Equipment is controlled at consoles outside the cell by an operator who can observe all operations by means of windows, mirrors and closed-circuit television. About half of the planned SEFOR fuel handling has been accomplished to date. Each item of equipment has performed its intended function dependably. Only a few malfunctions and failures have forced brief work stoppage or use of alternate equipment. (4 references) (auth)

20602 (INR-1119) FLUX FINE STRUCTURE, THERMAL, AND EPITHERMAL CELL PARAMETERS AND INFINITE MULTIPLICATION FACTOR IN WWR-SM LATTICE WITH INCREASED WATER-TO-FUEL RATIO. Jozefowicz, Edward T. (Institute

of Nuclear Research, Warsaw (Poland)). 1969. 17p. Dep. CFSTI (U. S. Sales Only).

The thermal microdistributions, thermal utilization factor, epithermal cell parameters ρ^{28}, δ^{25} and I.C.R. were measured in a water moderated lattice with 36% enriched UO_2 + Al fuel of multitube type WWR–SM with increased water content. The lattice contained a great number of the additional water channels regularly positioned. The comparisons with THERMOS Code calculations were performed. 8 references. (auth)

20603 (KAPL-P-3872) EXPERIMENTALLY MEASURABLE RELATIONSHIP BETWEEN ASYMPTOTIC FLUX TILTS AND EIGENVALUE SEPARATION. Wade, David C.; Rydin, Roger A. (Knolls Atomic Power Lab., Schenectady, N. Y.). 21 Mar 1970. Contract W-31-109-eng-52. 22p. (CONF-700304-3). Dep. CFSTI.

From Symposium on Dynamics of Nuclear Systems, Tucson, Ariz.

A standard perturbation theory analysis for a few group diffusion theory reactor models is used to obtain a model expansion for the asymptotic flux distribution following the introduction of a material perturbation. The modal coefficients are interpreted in terms of the physical meaning of the harmonic adjoint eigenfunctions. Neglecting all harmonic components after the first, it is found that the fundamental to first harmonic eigenvalue separation may be determined by the slope in a plot of perturbing reactivity versus a particular measure of the asymptotic flux tilt. The accuracy of the relationship is shown to be good over a large range of models and for various experimental configurations of the Solid Homogeneous Assembly (SHA). 5 references. (auth)

20604 (KAPL-P-3873) TIME DOMAIN NOISE MEASUREMENTS IN LOOSELY COUPLED CORES. Burke, J. A.; Moore, W. E.; Rydin, R. A.; Seemann, K. W. (Knolls Atomic Power Lab., Schenectady, N. Y.). 21 Mar 1970. Contract W-31-109-eng-52. 42p. (CONF-700304-4). Dep. CFSTI.

From Symposium on Dynamics of Nuclear Systems, Tucson, Ariz.

A method for estimating the eigenvalue separation of a reactor from cross correlation measurements of neutron fluctuations in two different parts of the core is presented. The SHA critical assembly is used to verify the results. (auth)

20605 (NP-18092) REACTOR INSTITUTE ANNUAL REPORT, 1968–1969. (Reactor Instituut Delft (Netherlands)). Oct 1969. 69p. (In Dutch). Dep. CFSTI (U. S. Sales Only).

The Interuniversity Reactor Institute (IRI) was founded in May 1969 as a cooperative venture of ten Dutch universities, the Organization for Applied Research (TNO) and the Reactor Centrum Netherlands (RCN). It has a staff of about 138 employees and about 80 students and guest researchers. During 1968 to 69 the reactor operated for 4150 hours. Training courses were held in the fields of neutron physics, reactor physics, core shielding, nuclear chemical technology and the medical application of isotopes. The research carried out included development of a cold neutron source, improvement of techniques for measuring the Mössbauer effect and new instrumentation for the study of ion mobility. The spectroscopy of thermal and fast neutrons and the performance of the reactor were improved. The radiation chemistry group studied problems of ion mobility and stability, compared the effects of ultraviolet and γ radiations and provided irradiation services for others. Activation analyses for mercury in pesticides and soils were automated. The ion-exchange capacity of peat and clay was determined for subsequent use in decontamination studies. Tracer studies were carried out for biological, industrial and agricultural applications. The health physics experiments included dosimetric investigations, dispersion of aerosols and the development of windowless counters. The 44 publications and 27 oral presentations by staff members are listed. (TTT)

20606 (WAPD-TM-933) AN ANALYTICAL STUDY OF THE MINIMUM CRITICAL MASS OF HIGHLY ENRICHED ^{235}U WHEN REFLECTED BY NATURAL URANIUM AND WATER MIXTURES IN OPTIMIZED LATTICES. Gray, A. W.; Jones, L. L. Jr. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar 1970. Contract AT-11-1-GEN-14. 52p. Dep. CFSTI.

An extensive analytical study has been undertaken to add to the limited data available concerning the minimum critical mass parameters for a spherical region of an optimum ^{235}U-plus-water mixture, when this region is reflected by natural U in an optimum light-water configuration. The conditions under which the central, enriched region would be exactly critical, with a minimum critical mass of ^{235}U, have been computed for various reflector configurations. These reflector configurations are: a homogeneous mixture of water and natural U at the optimum H to ^{235}U ratio; and natural U metal cylinders in an optimum U-water lattice. Specific calculations were performed in this latter system for 0, 225, and 17,000 Kg of natural U. The results of these calculations indicate that the minimum critical mass parameter for the central enriched region lies in the range of 75 to 200 grams of ^{235}U. The heterogeneous systems were analyzed using a Monte Carlo program. The validity of this analysis was established by application of the Monte Carlo program to a number of U-rod–water lattice systems (^{235}U enrichment in the range 0.71 to 3.0 w/o) for which experimental data is available. These results were then utilized to select appropriate criticality limits and rules for the underwater handling of natural and enriched U materials under conditions when both types of materials are available. 12 references. (auth)

20607 DESIGN STUDY OF FAST NEUTRON SOURCE REACTOR. An, Shigehiro; Nagai, Fumio; Wakabayashi, Hiroaki (Tokyo Univ.). Tokyo Daigaku Kogakubu Kiyo, A; No. 7, 46-7 (Dec 1969). (In Japanese).

The reactor program aims at setting up a facility for fundamental research and training, oriented in particular toward the field of fast and intermediate neutron research. (auth) (NSA of Japan)

20608 APPRAISAL STUDY OF REPORTED OPERATING EXPERIENCES OF VARIOUS FAST BREEDER REACTORS IN THE WORLD. 8. Nakagawa, Hiroshi; Hayase, Yuichi (Tokyo Electric Power Co.). Nippon Genshiryoku Gakkaishi; 12: 13-22(Jan 1970). (In Japanese).

The operating experiences of EBR-II and RAPSODIE during 1967 to 1969 are reviewed and evaluated. (NSA of Japan)

20609 METHODS USED TO STUDY DYNAMICS AND CONTROL OF A PULSED FAST REACTOR. Arhan, R. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan); 17: 149-63(Mar 1970).

The methods used to study dynamics and control of the pulsed fast reactor SORA are analysed and compared. The particular interest presented by a discrete-time kinetics theory for pulsed reactors is emphasized. General principles for obtaining the sampled transfer function of the reactor are given. 20 references. (auth)

20610 PULSED NEUTRON MEASUREMENTS OF THE MICRODISTRIBUTION IN A GRAPHITE PILE WITH EMPTY CHANNELS. Pregl, G.; Kalin, T.; Copic, M. (Josef Stefan Inst., Ljubljana, Yugoslavia). J. Nucl. Energy; 24: 49-52(Jan 1970).

It is shown that the dipole term of the angular distribution is sufficient for the correct description of the diffusion process perpendicular to channels; moreover, the microdistribution of the asymptotic mode can be measured by the pulsed neutron source method. The measured distribution is consistent with theoretical predictions based on static or on dynamic models. (UK)

20611 NEUTRON COLLIMATOR WITH A VARIABLE PASSAGE CROSS SECTION. Krebs, Karlheinz; Rochez, Rene (to EURATOM). U. S. Patent 3,487,218. 30 Dec 1969. Priority date 25 Mar 1965, Germany.

A neutron collimator with a variable passage cross-section is described. It consists of an open-ended, hollow lead through body penetrating the shielding of a nuclear reactor and two collimation blocks movably mounted therein. The opposing surfaces of the collimation blocks, defining the collimation channel, are oblique to the axis of the channel and radiation inhibiting means are provided between the body and blocks, the latter being capable of movement to a position wherein they effectively close the channel. (Offic. Gaz.)

20612 GETR ADAPTS TO CHANGING NEEDS. Hubbard, E. T.; Hovey, G. K. (General Electric Co., Pleasanton, Calif.). Nucl. News; 13: No. 2, 51-4(Feb 1970).

Design parameters of GETR are listed. The development program for the reactor is reviewed. Operating experiences are described. 3 references. (D.C.C.)

20613 NEW BREED OF RESEARCH REACTOR AT UNIVERSITY OF ILLINOIS. Nucl. News; 13: No. 2, 16-18(Feb 1970).

Modifications for 1.5 MW(t) operation of the University of Illinois TRIGA reactor are presented. Startup tests are described. (D.C.C.)

Rocket and Space Reactors

Refer also to abstract 19523.

20614 (N-70-13087) EXPERIMENTAL INVESTIGATIONS OF SNAP-8 SHUTDOWN CHARACTERISTICS. Hecker, Thomas P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov 1969. 73p. (NASA-TM-X-52730). CFSTI.

An experimental study of the shutdown of a SNAP-8 power conversion system was conducted to determine the transient response of the system to two shutdown modes, viz., a normal shutdown and an emergency shutdown. For the emergency shutdown, a failure of the condenser-coolant pump was simulated. Neither mode of shutdown resulted in parametric excursions beyond the limit considered safe for the components. Transient data for three normal shutdown tests and three emergency shutdown tests were presented. (auth) (STAR)

20615 (RN-DR-173) TREE ANALYSIS CODE (TRACE) PROGRAM E64106. Throckmorton, T. N.; Tayama, H. R. (Aerojet-General Corp., Sacramento, Calif.). Oct 1969. Contract SNP-1. 55p. Dep. CFSTI.

The TREE ANALYSIS CODE (TRACE) program performs a Monte Carlo simulation of fault trees to assist in analyzing large complex systems. It provides estimates of the probability of system failure prior to specified time. It detects minimal sets of components whose failure causes system failure. The time-to-failure for a component is assumed to be a random variable following an exponential distribution. Because system failures are normally rare events, the technique of importance sampling is used to reduce the number of trials required. (J.C.W.)

20616 NUCLEAR-PROPELLED PASSENGER VEHICLES FOR LUNAR AND PLANETARY EXPLORATION. Hunter II, Maxwell W.; McKereghan, Charles D. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Ann. N. Y. Acad. Sci.; 163: 466-75(4 Sep 1969).

The development of propulsion systems for manned space exploration is discussed on the basis of economic influences and technological considerations. The reusable/recoverable launch system, or variations of this basic concept, is considered. In a discussion concerning space transportation costs and the future of commercial traffic in space, correlations and comparisons are based upon conventional transportation cost procedures. To assess the effect of advance of technology over that becoming available today, the impact of gas-core reactor propulsion on the mission analysis is considered. The gaseous core engine shows promise of developing specific impulse up to 2000 to 3000 sec without requiring excessive engine weight. Such an engine is described as producing 80,000 lb of thrust at 2500 sec for an engine weight of 50,000 lb. A single module, containing on the order of 150,000 lb of propellant, would be sufficient to develop all of the propulsive requirements for a mission to Mars. (BBB)

Process Heat and Desalination Reactors

20617 (BARC-453) ECONOMIC IMPACT OF NUCLEAR POWER AND DESALINATION IN DEVELOPING COUNTRIES. Thomas, K. T.; Rajan, N. S. Sunder (Bhabha Atomic Research Centre, Bombay (India)). 1970. 39p. (CONF-691020-2). Dep. CFSTI (U. S. Sales Only).

From Symposium on Nuclear Power Costs and Economics Development, Istanbul, Turkey.

The possible impact of nuclear power and desalination in developing countries is analyzed. The beneficial effects of locating nuclear powered agro-industrial complexes in certain sites in India for simultaneous development of industrial and agricultural sectors of the economy are discussed in detail. In this connection economics of power intensive industries such as aluminum caustic-chlorine, fertilizers etc., have been evaluated. Comparative economics of production of nitrogenous and phosphatic fertilizers based on different feed stocks including power is presented. Two reactor sites are analyzed. (auth)

20618 (ORNL-TM-2380) ECONOMIC VALUE OF ENGINEERED SAFETY FEATURES IN SITING OF DUAL-PURPOSE DESALTING PLANTS. Collins, C. W.; Kolb, J. O. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 76p. Dep. CFSTI.

Construction of large dual-purpose nuclear desalting plants will require large siting distances or extensive use of engineered safety features at increased capital cost to reduce siting distances. Economical siting of nuclear power desalting plants thus involves a balance between costs for siting and conveying products to load centers and the costs of providing sufficient engineered safety features to reduce siting distances from product load centers. A study of the effectiveness of engineered safety features in reducing siting distances, the cost of site acquisition and the cost of conveying and transmitting product water and electricity in various quantities as a function of distance, and investigation of several examples of economic "trade-off" between reactor engineered safety features and siting costs is presented. (21 references) (auth)

20619 HOT BRINE ENERGY STORE. Margen, P. H. (Aktiebolaget Atomenergi, Stockholm). Energy Int.; 6: No. 5, 16-20 (May 1969).

The use of hot brine storage and heat exchange circuits for optimizing dual purpose desalination and power reactor operation is described. Various flow diagrams for hot brine systems are presented. The effects of plant size on economics are analyzed. 1 reference. (D.C.C.)

Marine and Portable Power Reactors

20620 NUCLEAR-POWERED SHIPS ARE COMING INTO SIGHT. Ellens, S. H.; Lindhout, A. H. Atoomenergie Haar Toepass.; 11: 295-300(1969). (In Dutch).

The prospects for the nuclear propulsion of certain types of ships appear realistic. The current trend toward faster and larger ships requires power plant of the order of 60,000 HP; at this level nuclear power plants for ship propulsion become economical. On the other hand, the longer delivery times and restrictions against nuclear ships in many harbors represent a drawback. Nuclear fuel will be more economical than conventional fuel but wages and insurance rates will be increased. Dutch shipyards must have to provide a choice of nuclear propulsion systems even before the orders are received in order to compete with conventional propulsion systems and with foreign yards. Research should be coordinated by the Reactor Centrum Netherlands or the Organization for Maritime Research. The Government and a cooperative of shipping companies may back the building of a prototype reactor. (TTT)

Reactor Theory

Refer also to abstract 19260.

Kinetics

Refer also to abstracts 20308, 20602, and 20610.

20621 (EURFNR-679) PRESENT STATUS OF PHYSICAL KNOWLEDGE OF THE MAIN REACTOR CORE DATA. Schmidt, J. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-966. 47p. Dep. CFSTI.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

A review of research programs related to the microscopic data for fission and breeder nuclei is presented. Revisions in cross section data are described. Analysis of ^{239}Pu fission is presented. 70 references. (D.C.C.)

20622 (NP-18028) SPHERICAL FUNCTION SOLUTION OF THE NEUTRON TRANSPORT EQUATION FOR A THREE DIMENSIONAL CYLINDRICAL SYSTEM. Diss. Nr. 4120. Maeder, Claude (Eidgenoessische Technische Hochschule, Zurich (Switzerland)). 1968. 54p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis.

For a cylindrical system of finite height, the monoenergetic stationary equation for neutron flux is solved. At large distances from the symmetry axis, the scalar flux is determined by a diffusion equation. Close to the axis, the neutron flux is treated by Fourier analysis. Characteristics of parameters are analyzed especially for high N-values in P_N approximation. The theory, applicable to calculating the scalar flux in reactors, could be adapted with only minor modifications to exponential assemblies. 15 references. (tr-auth)

20623 (KAPL-P-3875) ASYMPTOTIC FORMULAS FOR APPROXIMATE NUMERICAL SOLUTION OF THE REACTOR KINETICS EQUATIONS. MacMillan, D. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). 11 Feb 1970. Contract W-31-109-eng-52. 20p. (CONF-700304-1). Dep. CFSTI.

From Symposium on Dynamics of Nuclear Systems, Tucson, Ariz.

Given a system of differential equations in which some variables have very short response times, a related system of equations may be derived which may be solved numerically using reasonably-sized time steps to obtain a solution which is an asymptotic approximation to the solution of the original equation. The application of this technique to the equations of space-dependent reactor kinetics is described. The technique yields a sequence of asymptotic ap-

proximations of successively higher order; the first of these is the prompt jump approximation. Numerical results are presented for some space-independent reactor kinetics problems to indicate the kind of accuracy that may be expected from these approximations. (auth)

20624 (SC-DC-70-4753) COUPLED KINETIC-ELASTICITY CALCULATIONS OF PULSED REACTOR PERFORMANCE. Reuscher, J. A. (Sandia Labs., Albuquerque, N. Mex.). [13 Mar 1970]. 9p. (CONF-700304-2). Dep. CFSTI.

From Symposium on Dynamics of Nuclear Systems, Tucson, Ariz.

A calculational procedure which uses numerical techniques is described for determining the pulse profile, the fuel temperature rise, and the elastic response characteristics of the fuel element of pulsed reactors. 4 references. (D.C.C.)

20625 HEAT GENERATION AND TEMPERATURE DISTRIBUTIONS IN CYLINDRICAL REACTOR PRESSURE VESSELS. Ma, Benjamin M. (Iowa State Univ., Ames). Nucl. Eng. Design; 11: 1-15(1969).

Heat generation and temperature distributions in the wall of cylindrical pressure vessels of nuclear reactors are determined theoretically. The heat generation rate resulting from the absorption of primary gamma rays, neutron capture or secondary gamma rays, fast neutrons and thermal neutrons is in terms of radiation energy flux, energy absorption coefficient, buildup factor and exponential law of radiation attenuation. The heat generation rate is enhanced by the buildup factor of energy absorption. The temperature distribution in the pressure vessels is obtained by introducing the finite Hankel transform into the heat conduction equation. The results calculated for the heat generation rates and temperature distributions in the wall of the reactor pressure vessels are shown. 6 references. (auth)

20626 MULTIREGIONAL ANALYSIS OF TEMPERATURE FIELDS IN REACTOR TUBE BUNDLES. Trombetta, Michael L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Eng. Design; 11: 132-6(1969).

The multiregional analysis of temperature fields in tube bundles previously reported by Axford has been extended to include calculation of Nusselt numbers. Nusselt numbers based on a single region analysis may be in considerable error, even at relatively wide pitch-to-diameter ratios. 6 references. (auth)

20627 ASYMPTOTIC STABILITY OF REACTORS WITH ARBITRARY FEEDBACK. Akcasu, A. Z.; Akhtar, P. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 11: 155-62 (Jan 1970).

A theorem for the boundedness and asymptotic stability of a point reactor with an arbitrary feedback is stated and proved. The criteria obtained are shown to be essentially the same as those given by Akcasu and Dolfes. The theorem is applied to a reactor with an arbitrary linear feedback and to a xenon-controlled reactor with a flux reactivity coefficient whose feedback mechanism involves quadratic nonlinearity. It is also compared to a criterion obtained by Corduneanu in the case when delayed neutrons are ignored and the feedback mechanism is linear. (20 references) (auth)

20628 SPHERICALLY SYMMETRIC BOUNDARY VALUE PROBLEMS IN ONE-SPEED TRANSPORT THEORY. Case, K. M.; Zelazny, R.; Kanal, M. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 11: 223-39(Jan 1970).

A Green's function technique is applied to one-velocity neutron problems with spherical symmetry. The main advantage of the approach is that it bypasses the need to construct explicitly the appropriate spherical eigenfunctions. These can be directly deduced from this new formulation. (6 references) (auth)

20629 ENERGY-DEPENDENT BOLTZMANN EQUATION IN THE FAST DOMAIN. Nicolaenko, Basil (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 11: 174-84(Jan 1970).

Some aspects of the static energy-dependent Boltzmann equation in plane geometry using a continuous-energy formulation is presented. Solutions are found for a class of synthetic separable (but nondegenerate) energy-transfer kernels. Such kernels are representative, for instance, of neutron inelastic slowing down. The same problem is considered with the addition of a projection kernel (typical of neutron fission); it is shown that the solutions split into space-energy separable components and nonseparable "slowing-down transients." (32 references) (auth)

20630 ANISOTROPY OF SCATTERING IN NEUTRON TRANSPORT THEORY BY THE TWO-SIDED LAPLACE INTEGRAL METHOD. Boffi, V. C. (Comitato Nazionale per l'Energia Nucleare, Bologna). J. Math. Phys. (N. Y.); 11: 267-79(Jan 1970).

The effects of arbitrarily anisotropic scattering in establishing the eigenvalue spectrum of the operator associated with the stationary monoenergetic neutron transport equation in a medium of infinite extent are investigated through an extensive application of the two-sided Laplace integral theory. How the contribution of the discrete eigenvalues imbedded in the continuous part of the spectrum can explicitly be evaluated when inverting the bilateral Laplace transform of the sought distribution is shown by resorting to the Plemelj formulas, which are in order in the theory of the Cauchy integrals. (22 references) (auth)

20631 APPLICATION OF A COUPLED FISSION MODE APPROACH TO MODULAR REACTOR KINETICS. Stevenson, M. G.; Gage, S. J. (Univ. of Texas, Austin). J. Nucl. Energy; 24: 1-10(Jan 1970).

A formulation is presented which describes the time-dependent behavior of modular reactor systems through the use of a separation of the total flux into space- and time-dependent "fission modes." This method is applied to the calculation of transients in a fast modular system in which the fission modes are assumed to be space-time separable, and an outline is presented of the calculational method for the case in which the fission modes are not assumed to be space-time separable. (auth) (UK)

20632 NUMERICAL INTEGRATION OF DYNAMIC NUCLEAR SYSTEMS EQUATIONS BY OPTIMUM INTEGRATING FACTORS. Secker, Phillip Allen Jr. Tucson, Ariz.; Univ. of Arizona (1969). 103p.

Thesis.

A new numerical method called the method of optimum integrating factors is presented. The method is developed from a special integral equation solution of a first order ordinary differential equation. An integrating factor is formulated whose exponent is complex. By expansion of the integrand of the integral equation in Taylor series, a series approximation to the variable of integration is obtained which constitutes the basic numerical method. The advantages of the numerical method proposed are described. (Diss. Abstr.)

20633 SPACE DEPENDENT NOISE SPECTRA VIA THE TRANSPORT EQUATION. Cassell, J. S.; Williams, M. M. R. (London Univ.). J. Nucl. Energy; 23: 575-88(1969).

Exact expressions for the cross-power-spectral density in a uniform, infinite medium are calculated. One-speed transport theory is assumed, thereby enabling the deficiencies in diffusion theory for this type of problem to be assessed. The exact transport solutions become the simple diffusion theory ones when the points under consideration are more than about two mean free paths apart and the absorption is weak. Moreover, the diffusion theory expressions fail at high frequency. The nature of the cross-correlation function when the points are of the order of a mean free path apart are examined. It is shown that direct free flight correlations exist which could not possibly be predicted with diffusion theory. Specific expressions for the cross- and auto-power-spectral densities in plane, spherical and cylindrical detectors are given. (auth) (UK)

20634 CALCULATION OF THE RESULTS OF REACTIVITY PERTURBATIONS. A NEW METHOD TO DETERMINE THE SPACE- AND TIME-DEPENDENT FLUX DISTRIBUTION. Birkhofer, A. (Technische Hochschule, Garching, Ger.). Atomwirt., Atomtech.; 15: 132-4(Mar 1970). (In German).

A two-dimensional computer program was developed that allows calculation of both neutron flux and temperature at each point of the reactor core. The program is based on two nonlinear parabolic equations. Two cases of transient disturbances are calculated for a boiling water reactor. It is assumed that a control rod leaves the core with a mean velocity of 3.3 m/second. Flux of thermal neutrons, temperature, and reactivity are represented in three diagrams. (H.B.G.)

20635 SUMMARY OF TWO-GROUP CALCULATIONAL METHODS FOR HETEROGENEOUS URANIUM-WATER SYSTEMS. Laszlo, M. Kovacs. Energ. Atomtech.; 21: 402-6(Jul 1968). (In Hungarian).

The formulas for detailed calculation of the modified two-group diffusion method and the semiempirical formulas of the two-group input parameters needed for concrete calculation are collected. At the modified two-group diffusion approach the capture and the rise during the slowing down were taken into account and therefore the reactor-physical calculation belonging to uranium/water-systems corresponds very well with the measure results. 37 references. (auth)

Experimental Applications

Refer also to abstracts 20603, 20604, and 20643.

20636 (AI-AEC-12804) SODIFAZE: A STEADY-STATE MULTICHANNEL BOILING SODIUM CODE. Baroczy, C. J. (Atomics International, Canoga Park, Calif.). 15 Feb 1970. Contract AT(04-3)-701. 65p. Dep. CFSTI.

Conversion of a steady-state, multichannel, boiling water code for use with Na is described. The Na version (SODIFAZE) covers the vapor quality range of 0 to 0.10, mass velocity from 0.25×10^6 to 3×10^6 lb/hr-ft^2, and boiling temperature from 1600 to 2000°F. Code results show that the pressure drop–flow characteristics of a three-channel geometry with fixed heat input can be significantly different from that normally observed for a single channel. A review of two-phase pressure drop and liquid fraction data for liquid metals reveals the recent data compare well with existing correlations, whereas earlier data showed substantial differences. (30 references) (auth)

20637 (DP-1203) ^{238}U RESONANCE CAPTURE INTEGRALS FOR RODS OF UO_2, UC, AND U-METAL. Pellarin, D. J.; Baumann, N. P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Jan 1970. Contract AT(07-2)-1. 26p. Dep. CFSTI.

Uranium-238 effective resonance capture integrals were measured in rods of UO_2, UC, and U-metal. Rod diameters were 0.355, 0.500, 0.750, and 0.940 inch. Simultaneously activated thin foils of ^{238}U metal were the reference standards. The integrals included corrections for foil perturbation effects, counter efficiencies, and neutron spectra, which were determined from detailed measurements and computations. Analytical fits to the measured integrals, excluding the $1/v$ component, were $3.5 + 25.1\sqrt{S/M_U}$ barns for U-metal, $5.25 + 24.35\sqrt{S/M_{UO_2}}$ barns for UO_2, and $5.05 + 26.2\sqrt{S/M_{UC}}$ barns for UC, with S in cm^2 and M in grams. The integrals for the different chemical forms could not be correlated by any simple application of the equivalence theorem. (auth)

20638 (KFK-1079) RUNNING DESCRIPTION OF THE TWO DIMENSIONAL BURNUP PROGRAM ASB, VERSION OF THE PROGRAM BY INTERATOM FOR THE IBM 360/65. Mayer, L.; Sanitz, D.; Stein, E.; Willerding, G. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Nov 1969. 28p. (In German). (EUR-4317). Dep. CFSTI (U. S. Sales Only).

The two-dimensional burnup and management program ASB for the CDC 1604 A, has been adapted for the IBM 360/65. A description of the code and the input is included. (auth)

20639 (SU-326-P-9-3) ACTIVATION MEASUREMENTS OF THE DOPPLER EFFECT IN ^{238}U AND ^{232}Th AS A FUNCTION OF SURFACE AREA-TO-MASS RATIO. Final Report. Whitesel, Robert N. (Stanford Univ., Calif. Nuclear Engineering Lab.). Dec 1969. Contract AT(04-3)-326. 216p. Dep. CFSTI.

The Doppler effect for ^{238}U and ^{232}Th was measured in the Stanford Pool Reactor in thermal spectra. Measurements were made at six values of surface-to-mass (S/M) ratios ranging from 1.24 to 23.66 cm^2/gm for uranium foils and at S/M ratios of 6.81 and 19.67 for thorium foils. The experimental facilities and procedures are described, and the results are tabulated. (H.D.R.)

20640 DEVICE FOR MEASURING LOCAL HEAT FLUX ON THE SURFACE OF A FUEL ELEMENT. Michiyoshi, I.; Ohtsubo, A.; Takayasu, M. (Kyoto Univ.). Nucl. Eng. Design; 11: 69-76(1969).

The measurement of temperature fluctuations of the coolant is proposed as a method to detect time-variation of the local heat flux on the surface of a fuel element in a reactor cooled by turbulent flow of coolant. A simple out-of-core test loop was built and some experiments were performed to investigate the relation between the temperature fluctuation and the local heat flux. 7 references. (auth)

20641 UoV, A PROCEDURE FOR DESIGN CALCULATIONS OF SGHW-TYPE REACTORS. Brogli, R.; Junker, K.; Lys, L. A. (Swiss Federal Inst. for Reactor Research, Wurenlingen, Switzerland). J. Nucl. Energy; 24: 11-22(Jan 1970).

The computer Code UoV was used in studies showing the strong coupling between the neutronic and thermal characteristics of boiling light water cooled, heavy water moderated reactors using natural uranium or enriched uranium as fuel. Two different on-load refueling schemes were considered with respect both to their effect on power distribution and maximum fuel burnup. (auth) (UK)

20642 CRITICAL MASSES OF SPHERICAL AND HEMISPHERICAL ENRICHED URANIUM ASSEMBLIES. Tuck, Grover (Dow Chemical Co., Golden, Colo). J. Nucl. Energy; 23: 663-72 (Dec 1969).

The critical masses of oil reflected, enriched uranium metal assemblies were experimentally determined to obtain data for comparison with calculations. The center, or moderator region, of these assemblies was filled with oil or steel. The moderator region and the surrounding uranium region were spherical for one series of measurements and hemispherical for the second. The inner uranium region radius varied from 0 to 12 cm. Calculations were performed for the oil moderated and reflected spherical assemblies. The results of the calculations and experiment are compared. (auth) (UK)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 19135, 19181, 19186, 19188, 19190, 19191, 19256, 19263, 19271, 19380, 19394, 19404, 19473, 19477, 19482, 19495, 19496, and 19520.

20643 (ANL-7499) INELASTIC RESPONSE OF PRIMARY REACTOR CONTAINMENT TO HIGH-ENERGY EXCURSIONS. Cinelli, Gabriel Jr.; Gvildys, Joseph; Fistedis, Stanley H. (Argonne National Lab., Ill.). Nov 1969. Contract W-31-109-eng-38. 69p. Dep. CFSTI.

The inelastic response of primary containment to a high-energy axisymmetric excursion is found by numerical techniques. First, the equation of state for inelastic behavior is discussed. Then the basic conservation laws of mass, momentum, and energy are given in Eulerian coordinates. These equations are then transformed into Lagrangian coordinates and the finite-difference equations for numerical computation. Finally, the results of a sample problem calculation are given. 5 references. (auth)

20644 (LIB/Trans-240) NUCLEAR FUEL AND MATERIALS: U, Be, Zr. Mishima, Yoshitsuga. Translated by M. A. Hintze (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Kogyo Rea Metaru; No. 39, 19-22(Sep 1968). 17p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 23: 15749.

20645 NUCLEAR REACTOR AND DEVICE FOR FASTENING FUEL ELEMENTS. (to EURATOM). French Patent 1,546,009. 7 Oct 1968. Priority date 16 Nov 1966, Belgium. (In French).

REACTOR FUEL ELEMENTS—positioning device for, description of vertical in-core (M.L.S.)

20646 IMPROVEMENTS IN OR RELATING TO GRIPPERS. Hanke, Wilhelm (to European Atomic Energy Community). British Patent 1,178,896. 21 Jan 1970. Priority date 28 Nov 1966, Germany.

The design is given of a gripper for a loading machine for nuclear reactors. The grippers are intended for gripping a small number of specially shaped articles, such as the fuel elements. The gripper arm extends at the forward end; a lever is adapted to slide toward the object, engages the reactor part, and locks in the desired position. (J.C.W.)

20647 POSITIONING DEVICE FOR A NUCLEAR REACTOR LOADING MACHINE. Hanke, Wilhelm (to EURATOM). French Patent 1,546,022. 7 Oct 1968. Priority date 28 Nov 1966, Germany. (In French).

REACTOR LOADING MACHINES—design of, description of conceptual (D.C.C.)

20648 NUCLEAR FUEL ASSEMBLY. Normand, Georges; Venobre, Henri (to Commissariat a l'Energie Atomique). British Patent 1,185,135. 18 Mar 1970. Priority date 31 Jan 1968, France.

REACTOR FUEL ELEMENTS—assemblies of, description of perimeter located multiple guide lugs for positioning (D.C.C.)

20649 IMPROVEMENTS IN AND RELATING TO NUCLEAR FUEL ASSEMBLIES. Derussit, Richard; Rouge, Pierre; Thomas, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,184,980. 18 Mar 1970. Priority date 16 Nov 1967, France.

REACTOR FUEL ELEMENTS—spacers for cluster arranged parallel pencil type, description of parallel metal strip (D.C.C.)

20650 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Rouge, Pierre; Tissot, Roland; Vivien, Jean (to Commissariat a l'Energie Atomique). British Patent 1,185,140. 18 Mar 1970. Priority date 15 Mar 1968, France.

REACTOR FUEL ELEMENTS—plugging device for cylinder shaped, description of rotation actuated sealed edge (D.C.C.)

20651 TURBULENT INTERCHANGE MIXING IN FUEL BUNDLES. Rogers, J. T. (Atomic Energy of Canada Ltd., Peterborough, Ont.); Rosehart, R. G. pp 233-4 of Proceedings of the Second Canadian Congress of Applied Mechanics, Waterloo, Ontario, May 1969. Waterloo, Ont.; Univ. of Waterloo (1969). See CONF-690547.

Methods and formulas for predicting the basic turbulent interchange mixing rates in "clean" geometries and typical rod bundles are discussed. 18 references. (F.S.A.)

20652 FABRICATION OF FUEL ELEMENTS. van den Honert, A. (Philips I. G. voor Kernenergie, Eindhoven, Netherlands). Electrotechniek, 47: 222-4(May 1, 1969). (In Dutch).

The first fuel elements by the Physics Laboratories of Philips were fabricated in 1963 for the Reactor Centrum Netherlands. In 1968 about 168 elements were fabricated for the first Dutch nuclear power plant at Dodewaard. Quality control of nuclear fuel elements requires 100% compliance with the norm. If it is not possible to check every item, the production procedure and the product must be assessed statistically by a group which is independent of the production organization. A double batch criticality control was developed for the whole production line, dividing it into zones on the basis of the production procedures. A safety officer was assigned to each zone as being responsible for the enriched uranium. The fuel purity was expressed in boron equivalents as a measure of the thermal neutron absorption. The measurements were carried out in the low-flux reactor of the Reactor Centrum, using a pneumatic oscillator to change the sample and the standard. The criticality experiments indicated that production and control were satisfactory and the fabricated fuel elements were of high quality. (TTT)

20653 NUCLEAR FUEL ELEMENT AND PROCESS FOR MANUFACTURING SUCH AN ELEMENT. Gauthron, Maurice (to Commissariat a l'Energie Atomique). French Patent 1,543,379. 16 Sep 1968. Filed 8 Sep 1967. (In French).

REACTOR FUEL ELEMENTS—fabrication of cylindrical, description of method for (M.L.S.)

GENERAL

20654 (ANL-Trans-818) CORRELATION BETWEEN LIFE-SPAN AND FERTILITY OF VARIOUS MAMMALIAN SPECIES. Severtsova, S. A. Translated for Argonne National Lab., Ill., from Izv. Akad. Nauk SSSR; 931-50(1930). 25p. Dep. CFSTI.

20655 (BNL-tr-251) HEAT TRANSFER TO BOILING POTASSIUM IN UNIFORMLY HEATED TUBES. Aladev, I. T.; Gorlov, I. G.; Dodonov, L. D.; Fedynskii, O. S. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from pp 18-31 of Teploobmen, Gidrodinamika i Teplofizicheskie Svoistva Veshchestv, Moscow, Izd-vo, Nauka, 1968. 25p. Dep. CFSTI.

20656 (BNWL-CC-519) CYLINDRICAL ARRANGEMENTS OF UNIFORM SPHERES. Dean, R. Y.; Richardson, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [nd]. Contract AT(45-1)-1830. 45p. Dep. CFSTI.

20657 (CALT-822-2) THEORY OF s-d EXCHANGE INTERACTION IN DILUTE MAGNETIC ALLOYS. Madhukar, A.; Tsuei, C. C. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Apr 1970. Contract AT(04-3)-822. 11p. Dep. CFSTI.

20658 (COO-1198-704) SECOND- AND THIRD-ORDER ELASTIC CONSTANTS OF ALUMINUM AND LEAD. Suzuki, Tetsuro (Illinois Univ., Urbana). Feb 1970. Contract AT-(11-1)-1198. 32p. Dep. CFSTI.

20659 (COO-1620-5) KINETICS OF DEUTERATION OF PYRAZOLE. Wu, E. Chung; Vaughan, John D. (Colorado State Univ., Fort Collins. Dept. of Chemistry). [1969]. Contract AT(11-1)-1620. 16p. Dep. CFSTI.

The kinetics of deuteration of the 4 position and the 3(5) position in pyrazole was studied in sealed tubes at 200°C and higher temperatures. The mechanism proposed for 4-position deuteration involved general acid-catalyzed formation of sigma intermediates from the molecular and conjugate base forms of pyrazole. The rate of deuteration of the 3(5) position exhibited neither buffer catalysis nor pD dependence. This behavior is consistent with formation of an ylid intermediate from attack of the conjugate acid of pyrazole by OD^- ions. (auth)

20660 (COO-1790-2) "IN-SITU" ELECTRON MICROSCOPE INVESTIGATION OF THE NUCLEATION AND GROWTH OF SPUTTERED THIN FILMS. Annual Technical Progress Report, II. Hutchinson, Thos. E.; Sherman, Dudley (Minnesota Univ., Minneapolis. School of Mineral and Metallurgical Engineering). 29 Jan 1970. Contract AT(11-1)-1790. 19p. Dep. CFSTI.

20661 (IS-2185) FIT, A NONLINEAR LEAST-SQUARES FITTING PROGRAM TO OBTAIN INTERATOMIC FORCE CONSTANTS FROM OBSERVED PHONON FREQUENCIES. Prevender, Thomas Stephen (Ames Lab., Iowa). Oct 1969. Contract W-7405-eng-82. 17p. Dep. CFSTI.

20662 (IS-2186) TRIO, A COMPUTER PROGRAM FOR THE CALCULATION OF PHONON DISPERSION CURVES, ATOM POLARIZATION VECTORS, AND NORMALIZED STRUCTURE FACTORS. Prevender, Thomas Stephen (Ames Lab., Iowa). Oct 1969. Contract W-7405-eng-82. 13p. Dep. CFSTI.

20663 (IS-2210) A FORTRAN IV CRYSTALLOGRAPHIC SYSTEM OF PROGRAMS FOR GENERALIZED SUPERPOSITIONS. Hubbard, Camden R.; Jacobson, Robert A. (Ames Lab., Iowa). Nov 1969. Contract W-7405-eng-82. 34p. Dep. CFSTI.

The system of three programs calculates symmetry and general superposition maps for triclinic, monoclinic, and orthorhombic space groups. The program GEN generates the basic direct access data set. The program SYMM calculates a direct access symmetry map. The program ALS calculates a superposition map using the minimum function with weighting, origin shift, and multiple superposition options. ALS uses direct access storage to keep computer storage at a minimum. A detailed description of the use of the programs together with symbolic program listings is supplied. (auth)

20664 (JUL-Bibl.-7(2nd Ed.)(Suppl.1)) BIBLIOGRAPHY OF LITERATURE IN THE FIELD OF NUCLEAR SCIENCE. (Kernforschungsanlage, Juelich (West Germany)). 1969. 19p. (In German). Dep. CFSTI (U. S. Sales Only).

A list of 120 references in the field of nuclear science is presented. A subject index is also included. (W.H.K.)

20665 (LA-4289) A HISTORY-DEPENDENT RANDOM SEQUENCE DEFINED BY ULAM. Kac, M. (Los Alamos Scientific Lab., N. Mex.). 1 Oct 1969. Contract W-7405-eng-36. 4p. Dep. CFSTI.

20666 (LA-4359) APPLICATION OF PERMUTATION CYCLES TO STORAGE MANAGEMENT. Hundhausen, Joan R. (Los Alamos Scientific Lab., N. Mex.). 9 Jan 1970. Contract W-7405-eng-36. 4p. Dep. CFSTI.

20667 (ORNL-4506) OAK RIDGE DATA EVALUATION AND ANALYSIS LANGUAGE. Feliciano, M.; Nestor C. W. Jr.; Gove, N. B.; Calton, T. D. (Oak Ridge National Lab., Tenn.). Mar 1970. Contract W-7405-eng-26. 126p. Dep. CFSTI.

20668 (ORNL-HUD-12) SOLID WASTE MANAGEMENT PRACTICES: AN ANNOTATED BIBLIOGRAPHY AND PERMUTED-TITLE AND KEY-WORD INDEX. Boegly, W. J. Jr.; Griffith, W. L.; Sealand, O. M.; Baldry, W. E. (Oak Ridge National Lab., Tenn.). Feb 1970. Contract W-7405-eng-26. 363p. Dep. CFSTI.

20669 (ORNL-tr-2276) PREPARATION OF HIGH-PURITY CALCIUM CARBIDE. Peters, J. M. Translated by J. J. Pinajian and Lynda H. Kern (Oak Ridge National Lab., Tenn.), from Bull. Soc. Roy. Sci. Liege; 36: 688-91(1967). 4p. Dep. CFSTI.

A method for the preparation of high-purity calcium carbide is described that consists of reacting the calcium vapor with carbon. The calcium carbide obtained has a gray color and contains less than 1% free carbon and less than 0.5% Fe. It is necessary to use high-purity calcium carbide in the microsynthesis of tritiated benzene of high specific activity from gaseous tritium and also in order to obtain maximum yield for the synthesis of acetylene. (D.H.M.)

20670 (ORNL-tr-2301) ESTIMATION OF THE MOLECULAR WEIGHT OF THE ANOMALOUS COMPONENT OF MODIFIED WATER BY A CRYOSCOPIC METHOD. Deryagin, B. V.; Zheleznyi, B. V.; Zakhavaeva, N. N.; Kiseleva, O. A.; Konovalov, A. I.; Lychnikov, D. S.; Rabinovich, Ya. I.; Talaev, M. V.; Churaev, N. V. Translated by G. E. Moore (Oak Ridge National Lab., Tenn.), from Dokl. Akad. Nauk SSSR; 189: 1282-5(1969). 9p. Dep. CFSTI.

Calculations were carried out to permit an estimation of the molecular weight of polywater. A value of ~180 was obtained for average molecular weight. (M.C.G.)

20671 (ORO-3651-4) ELECTRICAL CHARACTERISTICS OF A METAL-SEMICONDUCTOR CONTACT. PART I. Prog-Report. Gossick, B. R. (Kentucky Univ., Lexington. Research Foundation). 1 Mar 1970. Contract AT(40-1)-3651. 35p. Dep. CFSTI.

20672 (PRNC-136) DISTRIBUTION OF FORAMINIFERS IN THE CABO ROJO PLATFORM AND THEIR PALEOECOLOGICAL SIGNIFICANCE. Seiglie, George A. (Puerto Rico Nuclear Center, Mayaguez). 1970. Contract AT(40-1)-1833. 35p. Dep. CFSTI.

20673 (SC-CR-70-6070) NONLINEAR DYNAMIC ANALYSIS OF SHELLS OF REVOLUTION BY MATRIX DISPLACEMENT METHOD. Report 69-77. Stricklin, J. A.; Martinez, J. E.; Tillerson, J. R.; Hong, J. H.; Haisler, W. E. (Texas Engineering Experiment Station, College Station). Feb 1970. Contract 82-2930. 102p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

20674 (SC-DC-70-4736) [BASIC PROGRAM FOR QUALITY CONTROL STATISTICS WITH OPTIONS]. Snodgrass, L. E. (Sandia Labs., Albuquerque, N. Mex.). [2 Feb 1970]. 36p. Dep. CFSTI.

20675 (SC-DR-70-112) TWO COMPUTERIZED METHODS FOR PLOTTING FUNCTIONS OF TWO INDEPENDENT VARIABLES. Sundberg, W. D. (Sandia Labs., Albuquerque, N. Mex.). Feb 1970. 37p. Dep. CFSTI.

20676 (SC-RR-70-50) K-SHELL AUGER AND RADIATIVE TRANSITION MATRIX ELEMENTS FOR Be-Xe AND IONS OF Al AND Cl. McGuire, Eugene J. (Sandia Labs., Albuquerque, N. Mex.). Feb 1970. 21p. Dep. CFSTI.

20677 (SC-T-70-4013) PROBLEM OF DOUBLE LAYER IN SHOCK-COMPRESSED DIELECTRICS. Ivanov, A. G.; Novitzky, E. Z. Translated by Marcel I. Weinreich (Sandia Labs., Albu-

querque, N. Mex.), from Zh. Prikl. Mekh. Tekh. Fiz.; No. 5, 104-7(1965). 10p. Dep. CFSTI.

20678 (UCLA-10-P-14-84) LOW LEVEL SELF-MEASUREMENT IN COMPUTERS. Report No. 69-57. Koster, Robert A. (California Univ., Los Angeles. School of Engineering and Applied Science). Oct 1969. Contract AT(11-1)-Gen-10. 167p. Dep. CFSTI.

20679 (UCLA-10-P-14-85) SEMIANNUAL PROGRESS REPORT. Estrin, Gerald (California Univ., Los Angeles. Dept. of Computer Science). Oct 1969. Contract AT(11-1)-Gen-10. 14p. Dep. CFSTI.

20680 (UCRL-50808) LOW-RESOLUTION MASS SPECTRA OF SOME SILICON-CONTAINING COMPOUNDS. Crawford, R. W.; Crawford, P. C.; Otto, C. H. (California Univ., Livermore. Lawrence Radiation Lab.). 12 Dec 1969. 26p. Dep. CFSTI.

Low-resolution mass spectra are presented for 13 silicon-containing compounds: methylsilane, dimethylsilane, trimethylsilane, tetramethylsilane, trimethylfluorosilane, dimethyldifluorosilane, methyltrifluorosilane, dimethyldimethoxysilane, tetramethoxysilane, hexamethyldisiloxane, octamethyltrisiloxane, octamethylcyclotetrasiloxane, and decamethyltetrasiloxane. These can serve as standard spectra for use in such applications as mass spectroscopic analysis of the decomposition products of organic silicon molecules. (auth)

20681 (UCRL-71935(Rev.1)) TIRED VOLT OR HOW DID A GOOD VOLT GET THAT WAY. Bostwick, W. E. (California Univ., Livermore. Lawrence Radiation Lab.). 5 Feb 1970. 17p. (CONF-691004-2). Dep. CFSTI.

From 24th Annual Conference on Instrument Society of America, Houston, Tex.

20682 (UCRL-Trans-1406) ON THE OPTICAL ANALOGY OF CERTAIN ELECTRONIC ARRANGEMENTS: FORMATION OF TEMPORAL IMAGES OF ELECTRICAL SIGNALS. Tournois, Pierre; Vernet, Jean-Louis; Bienvenu, Georges. Translated for Lawrence Radiation Lab., Berkeley, Calif., from Compt. Rend., Ser. A and B; 267: 375-8(5 Aug 1968). 6p. Dep. CFSTI.

20683 (UCSD-10-P-20-59-a) THE MARINE FOOD CHAIN AT ITS EARLY STAGES: AN ASSESSMENT OF PRESENT RESEARCH, HOW WELL WILL IT ANSWER TOMORROW'S PROBLEMS. Strickland, J. D. H. (California Univ., La Jolla. Inst. of Marine Resources). [1966]. 34p. (CONF-660574-1). Dep. CFSTI.

From 2nd International Oceanographic Congress, Moscow, USSR.